HORTICULTURE

PLANT PROPAGATION

HORTICULTURE
INSTRUCTIONAL-CUM-PRACTICAL MANUAL

Volume III

PLANT PROPAGATION

A.K. Dhote
Project Coordinator

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

July 1989
Sravana 1911

DVE-5T

Rs 7.50

Published by the Secretary, National Council of Educational Research and Training, Sri Aurobindo Marg, New Delhi 110 016, Photocomposed at Adprint Services 11, Rani Jhansi Road, New Delhi 110 055 and printed at A J Printers, Partap Bhawan 5 B S Z Marg, New Delhi-110 002

Foreword

The Programme of vocationalization of higher secondary education has been accepted by the country as it holds forth great promise for linking education with the productivity and economic development of the country by providing education for better employability of the youth

In view of the importance of the programme, the NCERT is making an all out effort to provide academic support to the implementing agencies in the States. One of the major contributions of the NCERT is in the field of corriculum development and in the development of model instructional materials. The materials are developed through workshops in which experts, subject specialists, employers' representatives curriculum framers and teachers of the vocational course are involved. These materials are then sent for try-out in schools and feedback is collected through questionnaires and through direct contact The materials are also sent to experts for comments before they are published.

The present manual on Plant Propagation has been developed in the manner described above and is meant for the students studying Horticulture and allied vocations. It is being published for wider dissemination amongst students and teachers throughout the country. I hope that they will find the manual useful.

I am grateful to all those who have contributed the development of this manual. I must acknowledge also the immense interest taken by Prof. A.K. Mishra, Head, Department of Vocationalization of Education, in inspiring his colleagues in their endeavours to develop instructional materials. Dr. A.K. Dhote, Reader, functioned as the Project Coordinator for the development of this title in association with Dr. A.K. Sacheti, Reader. They have my appreciation and thank for planning, designing and conducting the workshops, for technical editing and for seeing this manual through the Press.

Suggestions for improvement of this manual will be welcome.

P L. MALHOTRA
Director
National Council of Educational
Research and Training

New Delhi

Preface

Ever since the introduction of vocationalization in our school system by several States in our country the paucity of appropriate instructional materials has been felt as one of the major constraints in implementation of the programme and a source of great hardship to pupils offering vocational studies at the higher secondary stage.

The Department of Vocationalization of Education of the National Council of Educational Research and Training, New Delhi has started a modest programme of developing instructional materials of diverse types to fill up this void in all major areas of vocational education. The task is too gigantic to be completed by any single agency but the model material being developed by us might provide guidance and impetus to the authors and agencies desiring to contribute in this area. These are based on the national guidelines developed by a working group of experts constitued by NCERT.

The present manual is on "Plant-Propagation in Horticultural Crops" and is common portion of the Horticulture or related courses in a number of States. It contains activities (Practical exercises) to be performed by pupils with simple steps to follow, precautions to be taken and data to be obtained and processed. Each activity is complete with brief theoretical information, objectives, behavioural outcome, evaluation, etc. It is hoped that the pupils will find them immensely useful.

The manual has been developed by a group of experts as authors in a workshop held at the university of Agricultural Sciences, Bangalore. The names are mentioned elsewhere and their contributions are admirably acknowledged. Our thanks are also due to Dr K.M. Bhojappa, Professor and Head, Department of Horticulture, UAS Bangalore for the pains he took in varyfying the authenticity of contents of the manual. Dr. A.K Sacheti, Reader and Dr. A.K. Dhote, Reader, Department of Vocationalization of Education deserve special thanks for editing and bringing the materials in the present form. The assistance of all in the University of Agricultural Sciences, Bangalore

and Department of Vocationalization of Education, NCERT is also thankfully acknowledged.

ARUN K. MISHRA
Professor and Head
Deptt. of Vocationalization of
Education, National Council of
Educational Research and Training,
New Delhi 110 016

New Delhi

Acknowledgements

The following experts participated in the workshop conducted by the NCERT Their participation as contributors or reviewer is gratefully acknowledged.

Contributors

Dr. U.V. Sulladmath, Dr. A.T. Joshi, Dr. G.C. Sinha,
Mr R. Samiullah, Mr. M.A. Narayana Reddy,
Mr. K.T Shivashankar, Dr. A.K. Sacheti, Dr A.K. Dhote.

Reviewer

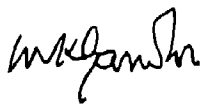
Dr K.M. Bhojappa

GANDHIJI'S TALISMAN

"I will give you a talisman. Whenever you are in doubt or when the self becomes too much with you, apply the following test :

Recall the face of the poorest and the weakest man whom you may have seen and ask yourself if the step you contemplate is going to be of any use to him. Will he gain anything by it ? Will it restore him to a control over his own life and destiny ? In other words, will it lead to Swaraj for the hungry and spiritually starving millions ?

Then you will find your doubts and your self melting away."



About the Manual

Under the programme of Vocationalization of Education about 20 different groups of vocational courses in the area of agriculture have been introduced by nine States and three Union Territories so far. These courses have been running for the last six or seven years. From the very beginning the Department of Vocationalization of Education in the NCERT has been working hand in hand with the State organisations concerned through various programmes organised for State officials, vocational teachers, and others In fact, by now the Department has conducted on-the-spot studies of vocational programme in large number of States, to find out merits and demerits of the programme and to suggest appropriate measure to resolve the problems in 'vocational agriculture education. These programmes have revealed that there was a great dearth of suitable textual instructional materials; the need for practical manuals, especially, was urgently felt. The development of instructional materials and the imparting of practical training become even more important when one considers the purpose for which the vocationalization of education programme has been launched. The main aim of the programme is to prepare the pupil for purposeful and gainful employment (wage-earning or self-employment).

The Department constituted a Working Group during the year 1982 to formulate guidelines for developing models for a variety of instructional materials.

Based on the guidelines formulated by the Working Group, Horticulture, which is an important and popular vocational course in agriculture, was selected by the Department for the purpose of development of instructional materials in a phased manner. To begin with, the development of instructional-cum-practical manuals has been taken up.

The content of Horticulture and similar courses offered by the States and Union Territories under different titles was thoroughly analysed and it was felt that six manuals would be necessary to cater to the needs of the course. The present manual on **Plant propagation in Horticultural Crops** is one of them. This manual is intended to help both teachers and pupils in the study of various methods of plant propagation as preparation for this vocation. While developing the

manual, care was taken that it should include the maximum number of Activity Units (practical exercise) so that it can fulfil the requirements of the course prescribed by the States and Union Territories in Horticulture as well as in other vocational courses.

These Activity Units are essential to develop the required vocational skills in the pupils. The manual explains in detail the 'what', 'why', and 'how' of these Units.

In the manual each Activity Unit has been dealt with under several sub-heads, viz , instructional objectives, relevant information, precautions, materials required, procedure, observations, expected behavioural outcomes and questions.

Before commencing the actual work under any Activity Unit, the teacher should know what exactly the pupils have to learn and do, and should also assess whether they will be able to do that. Therefore, in the beginning, instructional objectives for the pupils should be framed in behavioural terms by the teacher.

In order to acquaint the pupils with the Activity Unit the teacher should provide them with the required theoretical knowledge or information relevant to the activity. This will help the pupils to properly understand the Activity Unit. In other words, the 'what' and 'why' parts of the Activity Unit should be explained in advance by the teacher.

Once the pupils have understood the relevant theoretical instructions, the teacher should tell them about the precautions which are to be taken before and during the actual execution of the Activity Unit. This will facilitate smooth working. The 'how' part of the Activity should be explained by the teacher in the 'procedure' which pupil should follow while performing the Activity Unit.

Unter the sub-head 'observations', the teacher should tell what to observe and in view of that the pupil should observe the situation, take readings, note down the temperature and similar other points under each Unit; these may vary from Unit to Unit. Wherever calculations are required to be done to obtain the results, this should also be indicated under this head or under separate head.

At the end of the Activity the pupil will have acquired certain abilities which should be closely related with the instructional objectives formulated for each Activity Unit. These abilities should be listed under the sub-head 'expected behavioural outcomes'. Evaluation should be based on the abilities acquired and it should be done by the teacher

For evaluating each aspect, the teacher will use a four-point scale, i.e., A, B, C & D, and for each Activity Unit the Grade Point Average can be calculated as indicated below .

Suppose there are four aspects, each carrying equal weightage, and a pupil obtains 2A's, IC and ID and if A—4 point, B—3, C—2 and D—1 point; then, based on the grades, the pupil will get 11 points. When the number of points obtained is divided by the total number of aspects examined, it will give the Grade Point Average, which, in this case, is 2 75. The tabular presentation is as under .

Aspects	*Weightage*	*Grades Obtained*	*Toyao Points (weightage x point-equivalent to grade obtained)*	*Grade Point Average*
1	1	A	1 x 4 × 4	
2	1	C	1 x 2 × 2	11/4 × 2 75
3	1	D	1 x 1 × 1	
4	1	A	1 x 4 × 4/11	

At the end of the Activity Unit, some questions relevant to it are also given. The pupils should write the appropriate answers after the completion of the Activity Unit and teacher should examine them. If required, he should make suitable corrections and give suggestions. However, answers to these questions will not be considered for the purpose of grading.

Contents

Introduction

Plant propagation is the controlled reproduction of plant by man to perpetuate selected individual or groups of individual plants which have specific value to him. Civilisation is largely dependent upon man's ability to improve plants for food, shelter, clothing, recreation aesthetic fulfilment. When the flower is involved as an essential phase of increase in numbers, propagation is sexual. If the other plant parts excepting the flower are used for increasing number, propagation is a-sexual. Three different aspects, which may be considered as objectives, are involved in the study and practice or plant propagation. Firstly, plant propagation requires a knowledge of mechanical manipulation and technical skills, whose mastery calls for a certain amount of practice and experience. This may be regarded as the art of propagation.

Secondly, a knowledge of principles involved in plant growth and structure is essential for successful plant propagation This may be said to be the science of propagation. Such knowledge not only helps the propagator in understanding why he does the things he does, but also enables him to improve these practices.

A knowledge of specific kinds of plants and the appropriate methods by which these plants have to be propagated, is the third important pre-requisite for successful plant propagation.

With the growing need to step up production of fruits to meet the minimum requirements of the present and future, and the awareness among the people of the importance of fruits in the daily diet, there has been a tremendous increase in the demand for quality fruit plants of genuine varieties. To meet this sudden and unprecedented spurt in the demand for fruit plants, it is necessary that more and more nurseries are started all over the country.

Nursery enterprises, besides being highly remunerative, provide ample opportunities for young men for gainful employment This manual on plant propagation is prepared keeping in view the three important objectives of imparting knowledge of plants, principles involved and the skills necessary for successful propagation of fruit plants. The manual is expected to be useful for training the youth as gardeners, plant propagators and nurserymen. It will also be a useful reference manual for teachers and students of horticulture and for homegardeners.

Activity Unit:1

STUDY OF GARDEN TOOLS AND IMPLEMENTS

1.1. Instructional Objectives

The pupil should be able to :

— identify the different tools and implements used commonly in various operations involved in the perpetuation of horticultural and foresty plants;
— know the common name with synonyms of each tool/ implement;
— know the use of each of them;
— Understand the right operational technique;
— know about the proper maintenance, repairs and storage of them.

1.2. Relevant information

Important tools, implements and their uses

(a) Spade — used for loosening the soil, light digging, to prepare the irrigation channels, for opening of ridges and furrows etc

(b) Pick Axe — used for deep digging, opening of trenches, digging pits, loosening of soil etc.

(c) Crow Bar — is an iron rod usually of 1.5 m length, and 2 5-4.0 cm thick with one end flattened. The flattened end is used for digging pits in hard soils.

(d) Big Kudali — for light digging and loosening of soil.

(e) Hand Kudali — for light digging and other intercultural operations.

(f) Digging Fork Or Kudalıfork	for loosenıng the moıst soıl and mixing manures ın pıts.
(g) Trenching Hoe	used for light dıggıng, collectıon of soıl, ırrigatıon purposes and openıng of trenches.
(h) Garden Hand Cultivator	used for loosenıng the soil, breakıng clods and mıxıng of manures and fertilizers in the soıl.
(i) Garden Hand Rake	for removıng stubbles, small stones,levelıng of nursery beds and formation of small beds etc
(j) Garden Hand Fork	for loosening the soil, breaking the clods and coverıng of seeds in the seed beds.
(k) Garden Trowel	for lıftıng larger number of seedlıngs at a tıme from the nursery beds, seed pans or pots.
(l) Transplanting Trowel	for lıftıng the young seedlıngs along wıth a ball of earth.
(m) Dibbler	for makıng holes at the time of transplantıng of seedlıngs
(n) Grafting Knife	for graftıng purposes, has a single blade.
(o) Budding Knife	for buddıng purposes
(p) Graftıng Cum-Buddıng Knife	used for grafting and budding purposes, has two blades each for budding and graftıng specıally.
(q) Pruning Saw	used to cut thicker branches in top working.
(r) Prunning Knife	for prunıng of medium-thick branches in top working etc.
(s) Secateur	for cuttıng thınner branches
(t) Water Can With Rose	for waterıng seed beds, nursery beds and potted plants to avoid washıng off of the soil and damage to young seedlings.
(u) Bill Hook	thıs is commonly used for cuttıng big branches or to remove the old and dead branches from a tree.

(v)	Garden Shears	a big pair of scissors usually employed for clipping, trimming and pruning the hedge plants.
(x)	Tree Pruner	used for pruning shoots in a tree, higher above the reach of a man from the ground level.
(y)	Lawn Mower	for uniform clipping of lawn grass
(z)	Grass Shears	for cutting lawn grasses and soft and succulent twigs

1.3 Precautions

- Choose the right tool/implement for specific job.
- Check the tool/implement about its working condition before use.
- Examine the soundness of the tools/implements before and after their use
- Clean them, if necessary, wash with water and dry, oil them periodically.
- Store in the right way in the right place

1.4 Materials required

(i) Spade
(ii) Pick-axe
(iii) Crowbar
(iv) Big Kudali
(v) Hand Kudali
(vi) Digging fork or kudali fork.
(vii) Trenching hoe
(viii) Garden hand Cultivator
(ix) Garden hand rake
(x) Garden hand fork
(xi) Garden trowel
(xii) Transplanting trowel
(xiii) Dibbler
(xiv) Grafting knife
(xv) Budding knife
(xvi) Grafting cum-budding knife
(xvii) Pruning saw
(xviii) Pruning knife
(xix) Secateur
(xx) Water can with rose

(xxi) Bill Hook
(xxii) Garden shears
(xxiii) Axe
(xxiv) Tree pruner
(xxv) Lawn mower
(xxvi) Lawn shears

1 5 Precedure

Examine the different tools/implements individually. Get will acquainted with their :-

(a) Common name
(b) Working principle in brief
(c) Materials they are made of
(d) Uses for different operations

1.6 Observations

The pupil should record the following observations in the given table

Sl No	Name of the tool/implement.	Synonyms and local name	Uses	Cost	Sketches/ illustrations.

1.7 Expected behavioural outcome

The pupil acquires the following abilities to :

— identify and use the right tool/implement for specific job;
— use the tool/implement to carry out specific work efficiently and rapidly;
— maintain and store the tool/implement in working condition.

The teacher should evaluate the pupil for the above abilities.

1.8 Questions

(i) List out the different tools and implements used in the propagation of horticultural and forestry plants.
(ii) List out separately the tools and implements used in the :—
  (a) management of nurseries
  (b) propagation of plants by vegetative means
  (c) seedling production

(iii) Compare and contrast the uses of the following:
   (1) Pruning knife and pruning saw
   (2) Budding knife and grafting knife
   (3) Spade and pick-axe
   (4) Transplanting trowel and dibbler
   (5) Crowbar and big kudali
   (6) Garden hand cultivator and garden hand rake.

Activity Unit · 2

STUDY OF PROPAGATION STRUCTURES

2.1 Instructional objectives

The pupil should be able to .

— know the special structures and equipment necessary to provide the nursery plants optimum environmental conditions for normal physiological and growth activites ;

— identify the various propagation structures ;

— understand and develop skills to construct simple structures with available materials.

2.2 Relevant information

The three basic units of propagation structures are ·

(a) Structures with temperature control and ample light, such as a green house or hot bed, where seeds can be germinated or cuttings rooted.

(b) Structures into which the young-tender plants can be moved for hardening preparatory to transplanting out of doors. Cold frames or lath houses are useful for this purpose.

(c) Mist system/chamber. In the propagation of plants by leafy cuttings, one of the chief problems is to maintain the cuttings without wilting until roots are produced. Different propagation structures are :

(a) *Green houses and their types* .–

There are different types of green houses. The simplest is a shed-roof. Small inexpensive green houses can also be constructed from simple wooden poles and frames Commercial green-houses are usually independent structures of even-span gable-roof cons ruction, proportional so that the space is well utilized for convenient walk ways and propogating benches. Temperature may be controlled more accurately, ventilation is regulated more perfectly, and arrangements are more convenient for work. Green

houses are constructed in many sizes and types viz , (a) lean-to type, (b) the three-quarter-span, (c) the even-span-type

Construction : The green houses are designed to provide protection against cold and exposure of plants to maximum amount of sunlight

Plastic covered green houses

Light weight frames covered with various types of plastic films are popular for small house-garden structures as well as for large commercial installations. Plastic houses are usually of temporary construction, except when the more permanent, high cost covering, such as fiber glass panels are used.

Hot beds and cold frames

The host-bed is often used for the same purpose as a green house. Seedlings can be raised and leafy cuttings rooted in such structures Heat is provided below the propagating medium by electric heating cables, hot water, steam pipes, or hot air flues

Cold frames are similar to hot-bed except the heating arrangements.

Construction

Cold frames and hot beds are constructed in the same general manner. They are usually made of wood or concrete When wood is used, the structures can easily to made in such a way that they are movable. This makes it possible to set them up at different places each year as per the requirements. The standard width of cold frames and hot-beds is 2 meters and the length is a variable depending upon the space needed.

(b) *Lath Houses*

These structures are very useful in providing protection for container-grown nursery stock, especially in areas of high summer temperatures and high light intensity. Although protection is particularly important just after transplanting, well established plants also require lath house protection. In holding shade plants for any length of time, a lath house is almost a necessity. For tender species, the lath house is uses as an intermediate step between the cold and field planting.

Construction :

Lath house construction varies widely. Aluminium prefabricated lath houses are available but may be more costly than

wood structures More commonly, wood or pipe supports are used, set in concrete with the necessary supporting cross-members. Shade is provided with thin wood strips about 5 cm wide, placed to give 1/3 to 2/3 cover, depending on the need. The sides as well as the top, are usually covered

A woven plastic material-SARAN fabric is used widely in covering structures to provide shade. This material is available in different densities, thus allowing various intensities of light on the plants It is light weight and can be attached to heavy wire fastened to supporting posts.

(c) *Mist chambers/systems*

An intermittent-mist water spray over the cuttings in the rooting bed is a very effective aid in rooting the leafy cuttings of a great many kinds of plants. This system is widely used by propagators throught the world Such sprays provide a film of water over the leaves and cuttings. This lowers their temperature and increases the humidity around the leaves, thus reducing transpiration and respiration.

This mist technique facilitates the rooting of cuttings of plants which were previously considered very difficult or impossible to root. In addition, the intermittent mist keeps the slow-rooting cuttings alive for a longer period of time, giving them a chance to root before they die from dessication

Mist beds can be set up either in a green house for use in summer and winter, or out-of doors in a lath house or in open sun for use during the warmer months of the year Over these beds, nozzels are placed which produce a fine fog like mist. The nozzles are spaces such that they give a complete coverage of the bed

2.3 Precautions

- Use the right type of propagation structure for a given purpose, for specific plant species, and under a given season or weather condition.
- Keep the structures in proper working conditions. Keep necessary tools for timely repairs
- Keep the working part of the structure properly protected against pathogenic organisms, insects etc

2 4 Materials required

i. Various propagation structures
ii Simple tools for timely repairs
iii. Water source etc

2.5 Procedure

— Visit well established horticultural nurseries at nearby Agricultural Universities, Directorate of Horticulture, Experimental Research Stations, Private nurseries.
— Identify the various propagation structures.
— Study the construction details and working principles and materials they are made of
— Observe the common defects in the structures you visit and suggest improvements.

2 6 Observation

The pupil should record the following observations in the given table.

(a) *Observations on* propagation *structures*

Locality

Name of the structure	Dimentions of the structure	Materials it is made of	Type of plants grown	Special features if any-

(b) The pupil will make drawings of the plant growing structures shown to him during visits to the nurseries The drawings will be drawn to scale, showing different components and palnts grown.

He will also note special features such as regulation of temperature, light and humidity and their specific use in propagation of plants.

2.7 Expected behavioural outcome

The pupil acquires the following abilities to :

— understand the need for special structures in propagation,
— understand the use of specific structures for propagation of plants from cuttings, seeds, graft, etc,

— know that the artificial climatic conditions are possible to be created in special propagation structures ;
— select suitable propagation structures for a given species, under a given climatic situation

The teacher should evaluate the pupil for the above abilities

2.8 Questions

(i) List out the different propagation structures used in the propagation of seeds, cuttings, grafts etc

(ii) List out the different structures required separately for temperate and tropical situations

(iii) Describe with illustrations the construction of the following structures.

a) Green house

b) Hot bed

c) Cold frame

d) Lath house

e) Mist chamber

(iv) Distinguish between
(a) Green house and lath house
(b) Hot beds and cold frame

(v) Describe the usefulness of mist chamber in propagation of plants

Activity Unit:3

STUDY OF DIFFERENT POTS (CONTAINERS) FOR GROWING PLANTS

3 1 Instructional objectives

The pupil should be able to ·

— identify and classify the different pots;
— understand the uses of different pot containers;
— know the approximate cost of each item;
— judge the quality of the pots.

3 2 Relevant information

What are pot containers?

Post are the containers made of burnt porous clay in various sizes They provide the requisite amount of soil and root space to plants of different kinds and sizes. They have straight sides. They are wider at the top than at the bottom to hold the greatest bulk of compost where the feeding roots are located, and to facilitate easy removal of ball of earth intact with roots at the time of planting out or repotting. Usually the vertical height of the pot is the same as the internal diameter at the top

Pots off different sizes and their uses:

(a) 5 to 7 5 cm pots Used for potting singly very small seedlings during the first transplanting. They are shifted to larger pots as soon as the roots fill these pots.
(b) 15 cm pots : Used for growing well rooted cuttings of several kinds of plants and small plants of all kinds
(c) 22 5 cm pots Commonly used for growing alomost all kinds of annuals
(d) 37 5 to 45 cm pots · These large pots are used for growing Dahlias, Cannas, large crotons, shrubs, roses, etc.
(e) Pots of special sizes and shapes . Used for special purposes e.g Seed-pans, which are broader than deep and are used for seed sowing.

(f) Pots for plants like ferns, which have shallow root system, are less deep than the normal pots

(g) For seedlings of trees, as those of the mango, sapota and the like, with long tap roots, long pots are used for raising root stocks

(h) Orchids which require plenty of drainage and aeration for their roots are best grown in pots with perforations all over the sides

(i) pots used in the cultivation of big plants virtually consist of two distinct pots-one inside the other, a narrow space being left between the two for being filled up with water, damp moss, or sand to keep the soil in the inside pot containing the plant always moist.

Classification of pots

Pots may be classified into two groups viz. clay (earthen) pots and non-clay pots

Clay Pots

(a) Thumb pot It is small (5-10 cm) and is used for raising very young plants

(b) Madaki (15 cm) : Used for raising medium sized plants, generally root stocks.

(c) Parah : Used for raising herbaceous cuttings and seedlings.

(d) Seed Pan . Flat in shape with height less than the bottom Used for raising seedlings.

(e) Kunda (15-22.5 cm) Used for growing small and medium sized ornamental plants

(f) Nand (37.5 to 45 cm) . Used for growing big ornamental plants

(g) Pela Tall with narrow bottom, used for raising root stocks of mango, sapota, gauva etc.

(h) Perforated Pot . Used for growing aerophytes like orchids

(i) Hanging pots : Generally used in indoor for decoration of living rooms and canopies They are ornamental in shape and design.

In non-clay pots, the containers are made of material other than clay.

Non-clay pots :

(a) Flats · Essentially shallow, wood, plastic or metal containers, used for raising seedlings for early shifting

(b) Fibre pots (5 to 10 cm) Round or square, made of peat and fibre with added fertilizers

(c) Plastic pots · Available in round and square shape. They are non-porous, light in weights, easy to store and re-usable

(d) R.C.C. Pots Made of cement concretre for durability. Used as permanent containers in gardens and paths.

(e) Bamboo pots Bamboo strips are woven into pots of different shapes and sizes. They are disposable

(f) Metal containers . Used containers, re-used after making holes at the junctions of side and bottom

(g) Brass pots, porcelain pots and glass pots . These are fancy containers used for interior decoration These containers are used as covers to the inner pots is which plants are grown.

(h) Polyethylene bags . Small polyethylene bags with holes punched in the bottom and sides for drainage and aeration, may be filled with a porous rooting medium or pot-mixture for growing young stock plants, cuttings etc

3.3 Precautions

— The pots should be of standard size

— They should be well burnt.

— They should have sufficient drainage holes depending upon the size and use

— Care should be exercised in purchasing the earthenpots. They should not have protruding edge at the tops and bulge or curve in the middle of the sides.

3.4 Materials required

Pots of different shapes and sizes of all types (as listed under 3.2).

3.5 Procedure

— Know the name and understand the specific use of each type of pot.

— Note the various sizes and shapes of different kinds of pots.

— Study carefully the various parts of the pot
— Note the dimensions and record the measurements.
— Critically verify the number of drainage holes, position and size of the hole.
— Test the quality of the earthen pot by gently tapping with a finger or a dry stick or a small piece of stone. If it sounds metallic, it is well burnt and the clay used is of good quality.

3.6 Observations

The pupil should record the following observations in the given table

Name of the pot	Dimensions			Volume	No. of exposition of drainage holes	Material made of	uses
	Height	Diameter Rim	Bottom				

3.7 Expected behavioural outcome

The pupil acquires the following abilities to .

— identify the various pots used in plant propagation ;
— understand the various parts of the pot ;
— know the uses of pots of different types.

The teachers should evaluate the pupil for the above abilities.

3.8 Questions

(i) Describe the various parts of a plant pot with illustration.
(ii) Measure the dimensions of given pots and work out the volume of the pot mixture required for filling 100 pots.
(iii) List out qualities of an ideal pot.
(iv) What are the special types of pots ?

Activity Unit : 4

STUDY OF DIFFERENT MEDIA FOR PROPAGATION

4.1 Instructional objectives

The pupil should be able to :

— know the meaning of propagating media ;
— know that there are several media and mixtures of different media ;
— understand the qualities/characteristics of a good propagating medium ;
— determine the water holding capacity of each medium.

4.2. Relevant information

What is a medium ?

The plant propagating medium is defined as "any agency that enables and helps the seed or any plant part kept in it, in getting good germination or rooting".

Characteristics of a good medium :

(a) The medium must be sufficiently firm and dense to hold the seed or cuttings in place during germination or rooting.
(b) Its volume must be fairly constant when either wet or dry. Excessive shrinkage after drying is undesirable
(c) It must have a good water holding capacity so that watering does not have to be too frequently.
(d) It must be sufficiently porous so that excess water drains away permitting adequate aeration.
(e) It must be relatively free from weed seeds, nematodes and noxious (harmful) disease causing organisms.
(f) Its PH must be suitable for the plant being propagated or grown.
(g) It must be free from excess salts.
(h) It should withstand steam sterilization without any delecterious effects.

(i) It should not undergo any chemical change during steriliza ion or afterwards

Types of media ·

There are over ten different media and their chemical composition are as below :

(a) **Soil and its composition** · Soil is composed of materials in solid, liquid and gaseous state in proper proportions for a satisfactory plant growth. The texture of soil refers to the relative proportion of :

(i) Sand (2 to 0.05 mm in particle diameter)
(ii) Silt (0.05 to 0.002 mm —do—
(iii) Clay (less than 0.002 mm —do—

The principal textural classes are Sand, sandy loam, silt loam, clay loam and clay A typical sandy loam may consist of 75% sand, 14% silt and 11% clay.

Soil structure refers to the arrangement of the above particles in the entire soil mass.

(b) **Sand and its composition** : Sand consists of all rock grains (of size ranging from 0 05 to 0.20 mm diameter) formed as a result of weathering of various rocks. Its mineral composition depends on the type of the parent rock. Quartz sand, generally used for propagation purposes, consists chiefly of a sillica complex The type of sand used in plastering is satisfactory for rooting of cuttings. It is worthwhile mentioning that :

(i) Sand is the most widely accepted rooting medum for cuttings (particularly for ever green species).
(ii) Relatively inexpensive and readily available.
(iii) It is not as retentive of moisture as other media, Hence, needs frequent watering.
(iv) It should be fine enough to retain some moisture around the cuttings, yet course enough to allow water to drain off.

(c) **Peat and its composition** · Peat consists of the remains of aquatic, marsh, bog or swamp vegetation, which has been preserved under water in a partially decomposed state. Peat is often added to sand in varying proportions, mainly to increase the water holding capacity of the mixture. The combination makes an excellent rooting medium for cuttings of most species.

(d) **Sphagnum moss and its composition** : Commercial sphagnum moss is the dehydrated remains of such acid bog plants as *Sphagnum papillosum* and *S. palustre*. It is relatively sterile, light in weight, has a very high water holding capacity (absorbs 10-20) times its weight of water)

Stem and leaf tissues of sphagnum moss consist largely of groups of water holding cells. It is generally shreded before it is used as a propagating medium. It contains very small amount of minerals. It is also used with sand in equal parts for rooting stem, leaf and root cuttings.

The moss material that is used under our conditions as a propagating medium is an epiphytic bryophyte which grows abundantly on the tree trunks and branches in the tropical and sub-tropical rain forests. As it possesses similar characteristics as sphagnum moss and since sphagnum moss is not available in large quantities in our country, the epiphytic bryophyte is used in place of sphagnum moss

(e) **Vermiculite and its composition** . Vermiculite is a micaceous mineral which expands markedly when heated. Chemically, it is a hydrated magnesium-aluminium-iron silicate. It is very light in weight, neutral in reaction, insoluble in water and able to absorb and retain large quantities of water.

(f) **Leaf mold and its composition** Maple, oak and pongemia are among the leaf types suitable for leaf mold. In preparing such a medium alternate layers of leaves and soil are heaped up preferably under the shade. Watering once in a day will has ten the decomposition of the leaves The leaf mold will be ready for use in about 10-11 months It may contain nematodes, weed seeds and noxious insects and diseasses, so it should be sterilized before using.

(g) **Shreded bark, sawdust, wood shavings** : Can be used in soil mixes, serving much the same purpose as peat moss.

(h) **Potting mixtures**

(i) For potting of rooted cuttings and young seedlings : 1 or 2 parts sand plus 1 part loamy soil plus 1 part peat moss or leaf mold.

(ii) For general container grown nursery stock : 1 part sand plus 2 parts loam soil plus 1 part peat moss or leaf mold plus 1/2 part well rotten F.Y.M.

4.3 Precautions

— Procure the right medium for specific purpose.
— Prepare potting mixture of the required composition for specific groups of plants.

4.4 Materials required

i. Propagation media :

(a)	Soil	(f)	Leaf mold
(b)	Sand	(g)	Shreded bark
(c)	Peat	(h)	Saw dust
(d)	Sphagnum moss	(i)	Wood shavings
(e)	Vermiculite	(j)	Coir dust

ii. Measuring cylinders (1000 ml)
iii. Physical balance
iv Strainers
v. Water
vi. Glass containers.

4.5 Procedure

Determination of Water Holding Capacity of Media :

— Weigh a suitable quantity (25-50 gm) of the propagating medium.
— Transfer the medium to the glass container (Do not compress the medium).
— Add measured quantity of water (the rooting medium should be immersed completely in water).
— Allow it to stand for about 5 minutes (Do not disturb or compress the medium)
— After the required time, drain off the excess water from the container by decantation.
— Measure the water drained (in ml).

4.6 Observation

The pupil should record the following observations in the given table :

S.No.	Medium	Physical characteris-tics of the media	Weight	Water held by the medium	Water holding capacity of the medium

4.7 Calculations

The pupil should calculate the water holding capacity of the medium by applying the following formula .

Water holding capacity of the medium = $\frac{(w-x)\ 100}{X}$

Where, W=Quantity of water held by the medium after 5 minutes

X =Weight of medium

4.8 Expected behavioural outcome

The pupil acquires the following abilities to :

— use the right type of propagating media for specific purpose;

— determine the water holding capacity of the medium;

— understand the desirable qualities/characteristics of each of the different media used commonly in propagation of plants and in growing container plants

The teacher should evaluate the pupil for the above abilities

4.9 Questions

(i) Porous and well drained medium facilitates easy germination of seeds to a greater extent as compared to non-porous, poorly drained medium Give three reasons.

(ii) Saturated medium may retard or entirely prevent the germination of most of vegetable and flower crop seeds. Explain

(iii) In general firming of the medium immediately after sowing the seed facilitates germination. Give reasons.

(iv) Enumerate the qualities of a good propagating medium.

(v) Mention five important propagating media used in the propagation of horticultural and forestry plants.

(vi) Mention the ideal propagating media that could be used in air-layering in order of merit.
(a) (b) (c)

(vii) What should be the proportion of sand, soil and leaf mold in a potting mixture for rooting of cuttings?

Activity Unit : 5

IDENTIFICATION OF SEEDS AND STUDY OF SEED VIABILITY

5.1 Instructional objectives

The pupil should be able to know :

— the different parts of the seed;
— the importance of nucellar seedlings;
— the external features of seeds to identify them in the field/ laboratory;

5.2 Relevant information

Advantages or seed propagation

Majority of the plants are propagated through seeds. The seedlings produced are easy to handle, hardy, highly variable and expensive.

Types of seeds

On the basis of number of embryos present seeds are classified into (i) Monoembryonic, (ii) Polyembryonic.

Monoembryonic seeds are those which contain only one gametic embryo and produce plants which are genetically variable. A polyembryonic seed is one which produces two or more embryos per seed of which one is gametic and others are nucellar. The nucellar seedlings being of somatic origin are highly uniform and true to type They are used as root-stocks.

Parts of the seed

The plumule (rudimentary shoot) and the radicle (rudimentary root) together known as primary axis are the important parts of a seed.

What is seed viability?

The capacity of the seeds to germinate under favourable conditions is known as viability This can be determined by (a) Germination test and (ii) Tetrazolium test.

Seed identification

To maintain genetic purity of the plants, one should have knowledge about the characters of the seeds such as seed weight, size, markings and germination percentage.

5.3 Precautions

— Select seeds free of impurities and without internal dormancy for actual germination test

— Prepare tetrazolium solution and apply it under darkness or subdued light

— Provide enough time for germination of seeds.

5 4 Materials required

i. 200 healthy bean seeds and 200 freshly extracted lime seeds
ii. Twenty sets of petri dishes.
iii. Fifty discs of filter papers.
iv. Four beakers of 250 ml capacity.
v. One wash bottle with distilled water.
vi. Triphenyl tetrazolium trichloride (TTC) solution

5.5 Procedure

5.5.1 *Polyembryony*

Soak 20 seeds of bean and lime in separate beakers for 3-4 hours. Remove the seed coat and count the number of embryos present by recording the number of plumule with radicle present in the seed. Work out the average number of embryos per seed.

5.5.2 *Germination Test*

Prepare 10 sets of petridishes. In each petridish, sow 10 bean seeds and 10 limes seeds separately and allow them to germinate. Keep the filter paper moist by adding water through water bottle.

After 3-4 days take the germination count.

Record the total number of seeds germinated and those not germinated.

5.5.3 *Determination of viability in seed by chemical method :*

Prepare 0 5 per cent TTC solution by dissolving 500 mg

Triphenyl Tetrazolium Trichloride (TTC) in 100 ml of distilled water and store it in a coloured bottle.

In the petridishes put 20 embryos (plumule + radicel) of bean seed and lime seed separately. Treat them with 0.5 per cent TTC solution and keep them in darkness overnight.

Next morning observe for the colour change in the embryos The embroys which are viable will react with TTC solution and develop pink colour, whereas the non-viable ones will remain unaffected.

5.5 4 *Identification of seeds :*

For identification of the seeds of horticultural crops of your region, determine average seed weight by weighing 100 seeds and average seed size by taking measurements of 10 seeds. Record the colour of the seeds and special markings if any. Prepare a rough sketch of the seed.

5.6 Observations

The pupil should record the following observations in the given table :

i) Average number of embryos per seed.

Crop	*Total No. of seeds dissected*	*Total No. of embryos counted.*	*Average No. of embyros per seed.*
1.			
2			
3.			
4.			
5.			

ii) *Determination of viability of seeds by chemical methods :*

Crop	*Total No. of embryos treated with TTC*	*Total No. of embryos developing red colour.*	*Viability percentage*

(I) Observation on germination of seeds ·

Crop	Total No of seeds sown	Total No of seeds germinated	Germination percentage.
1.	Bean		
2	Lime		

(iv) Identification of seeds of Horticultural Crops ·

No.	Crop	100 seed weight	Average Wt.	100 seed size	Average size	Colour	Marking	Figure.

5.7 **Calculations**

Crop . Beans

i) Average number of embryos per seed in beans =

$$\frac{\text{Total No. of embryos separated}}{\text{Total No. of seeds dissected}}$$

ii) Germination percentage in beans =

$$\frac{\text{Total No. of seeds germinated x 100}}{\text{Total No. of seeds sown}}$$

iii) Percentage of viable embryos in beans =

$$\frac{\text{Total No of embryos giving red colour with TTC}}{\text{Total No. of embryos subjected to TTC test.}}$$

Crop : Lime

i) Average No. of embryos per seed in lime =

$$\frac{\text{Total No. of embryos separated}}{\text{Total No. of seeds dissected}}$$

ii) Germination percentage in lime seeds. =

$$\frac{\text{Total No. of Seeds germinated X 100}}{\text{Total No. of seeds sown}}$$

iii) Percentage of viable embryos in lime. =

$$\frac{\text{Total No. of embryos giving red colour with TTC}}{\text{Total No. of embryos subjected to TTC test.}}$$

5.8 Expected behavioural outcome

The pupil acquires the following abilities to ·

— know the importance of seeds in plant propagation,
— know the differences between monoembryonic and polyembryonic seeds;
— know the importance of nucellar seedlings;
— determine germination percentage;

— find out seed viability;
— identify the seeds of horticultural crops of the region

The teacher should evaluate the pupil for the above abilities.

5.9 Questions

i Describe the parts of a dicotyledonous seed

ii What is a polyembryonic seed?

iii. What is the importance of nucellar seedlings?

iv. What is seed viability? How do you determine it? Describe two methods.

Activity Unit : 6

STUDY OF PRE-GERMINATION SEED TREATMENT

6.1 Instructional objectives

The pupil should be able to

— know why the pre-germination treatments are required;

— understand the effects of pre-germination treatments on seed germination.

6.2 Relevant information

Seeds of certain horticultural crops may fail to germinate due to the presence of impermeable seed coverings (seed coat), chemical inhibitors (inhibitory dormancy) and dormant embryos (embryo dormancy). Under the above circumstances, pre-germination seed treatments are essential to improve the germination.

There are four important pre-germination seed treatments :

Mechanical scarification

Acid scarification

Stratification

Soaking the seeds in water.

(i) Mechanical scarification

It is a process of mechanically altering the seed coat by breaking or scratching the seed coat to make it permeable to water and gases

(ii) Acid scarification

This is done to modify the hard or impervious seed coat by using strong corrosive concentrated sulphuric acid which acts on the seed coat. The duration of the treatment should be standardized in case of each seed.

(iii) Stratification

It is a process of exposing the moist seeds to lo temperature, often required to bring about the prompt ar uniform seed germination. This treatment permits physi logical changes to occure within the embryo of the seed, whi is known as after ripening.

(iv) The seeds are aloowed to stary for few minutes (5-10 min in hot water and then, over night in cold water, This will s the hard seed coat, remove inhibitors and reduce the tir germination.

6.3 Precautions

- While rubbing or cracking the seeds, care must be taken to s that embryo is not damaged.
- Mechanical scarification is for large sized seeds. Such seeds a to be used in small quantities.
- Acid scarification is for small sizes seeds. During acid treatmen the charring should affect only the seed coat and not the embry
- Handle the acid with care.
- During stratification, keep the seeds always moist.
- Do not leave the seeds in hot water for a long period (not mo than 10 minutes).
- Dry the treated seeds under shade.

6.4 Procedure

a. *Mechanical scarification*

Materials required

1 Sand paper or file or hammer.

ii. Sapota seeds (20 numbers).

Procedure

- Rub the seeds on sand paper or cut with file or crack the se coverings with a hammer.
- Sow the scarified and unscarified seeds separately in seed be

b. *Acid scarification*

Materials required

(i) Concentrated sulphuric acid (specific gravity 1.84)

(ii) Glass beakers (250 ml)

(iii) Glass rod.

(iv) Separating funnel

(v) Guava seeds (about 250 in number)
(vi) Tap water

Procedure

— Take the given dry seeds in a glass beakers.
— Add concentrated sulphuric acid gently in the ratio of two parts of acid for one part of seed by volume.
— Stir the contents at regular intervals to produce uniform results.
— Allow the seeds to remain in acid for about 20-30 minutes
— At the end of the treatment, remove the acid.
— Wash the seeds the roughly to remove all acid and sow them immediately or dry the seed and store

c *Stratification* ·

Materials required

i. Media (fine sand or chopped peat moss or vermiculite)
ii. Container. (wooden box 2'x1'x6© or polythen bags or glass jar or cans.
iii. Apple or grape vine seeds (about 1000 in number).

Procedure

— Take fresh or moistened apple seeds.
— Take the moist (but not wet) fine sand and arrange a layer of about 5-8 cm thickness at the bottom of a wooden box.
— Arrange moist seeds in a layer of 3 to 5 cm over the layer of sand.
— Repeat the layers of the sand and seeds alternating with each other.
— Keep the box at a temperature of 0-10°C for about one to two months.
— At the end of the treatment, remove the seeds and sow them immediately.

d. *Soaking the seeds in water* ·

Materials required

(i) Beaker (250 ml)
(ii) Hot plate or burner
(iii) Thermometer
(iv) Water
(v) Glass rod
(vi) Gulmohar seeds (50 seeds).

— Remove the heat immediately by adding cold water.
— Soak the seeds in cold water for 12-24 hours.
— Select swollen seeds for sowing.

6.5 Observations

The pupil should record the following observations in the given table .

1. Time taken for germination
2 Percentage of germination

Sl. No.	*Seed Name*	*Pre-germination seed treatment.*	*No. of seeds sown.*	*No. of seeds germinated*					
				4th day	*6th day*	*8th day*	*10th day*	*12th day*	*14th day*
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.

Total No. of seeds germinated	*% of germination*	*Remarks*
11.	12.	13.

6.6 Calculations

Note : The pupil should calculate the percentage of germination as per the formula given below.

$$\text{Germination per cent} = \frac{\text{No. of seeds germinated X 100}}{\text{No. of seeds sown}}$$

6.7 Expected behavioural outcome

The Pupil acquires the following abilities to :

— use different methods to overcome seed coat dormancy;
— use different methods to overcome embryo and inhibitory dormancy;
— understand the beneficial influences of hot water on seed coat in seed germination;

appreciate the importance of pre-germination treatments for improved seed germination;
calculate the germination percentage.

The teacher should evaluate pupil for the above abilities.

6.8 Questions

(i) What is scarification?

(ii) How concentrated sulphuric acid alters the seed coat to promote early germination?

(iii) Name six horticultural crops which require pre-germination seed treatments and why?

(iv) Distinguish between scarification and stratification

Activity Unit : 7

PREPARATION OF SEED BED, SEED PAN AND SOWING OF SEEDS

7 1 Instructional objectives

The pupil should be able to

— knqw the importance of raising seedlings in seed beds and seed pans;

— learn the selection of suitable site and containers to raise seedlings,

— understand the optimum requirements for sowing the seeds and for seedling growth,

— prepare seed bed and seed pan to raise to seedlings;

— sow the seeds in the beds and pans

7 2 Relevant information

Most of the vegetable crops, ornamental plants and certain fruit crops are propagated by seeds Such of those horticultural crops which can stand transplanting shock are raised in seed bec or seed pans.

Why to raise the seedling stocks in seed pans and seed beds?

It is very easy and convenient to look after the young tender seedlings growing in a small but compact area.

Seedlings can be easily protected against insect pests and diseases

Favourable conditions for growth can be provided with ease to the growing seedlings.

Economy in space.

More time would be available for preparation of the land, where transplanting is to be done.

Economy in the use of costly seeds including F¹ hybrid seeds.

Very minute seeds are best sown in seed pans.

Suitable site and soil for seed bed

A sheltered sunny situation away from big trees but nearer to the water source is an ideal place for preparing the seed beds.

The soil of the seed bed shold be fine textured, porous and firm to provide good aeration and drainage for better germination and seedling growth. Loam and sandy loam soils with plenty of organic matter are good, provided they are free from disease causing orginisms.

Sowing of seeds

Seeds may be sown by broadcasting or in rows. Sowing in rows is advantegeous due to the following reasons

- Easy to remove the seedlings for transplanting.
- Better circulation of air around the stems to prevant damping off
- Cracking of soil over rows of seeds by the upward pressure permits some of the weaker ones to develop.
- Plant protection becomes easier and effective.
- Weeding and other cultural operations are made easy.

Depth of sowing

The depth or sowing depends on the size of seeds. In general, the seed has to be covered to a depth about four times its diameter. Very fine seeds should be covered lightly, if at all. A flat bottom furrow is better than 'v' shaped ones to avoid overcrowding of seeds.

7.3 Precautions

- Prepare the raised beds to avoid damping off. The surface of the beds should be made fine and smooth.
- Provide sufficiently large drainage hole(s) to the seed pans
- Use porous media to provide good aeration.
- Disinfect the media before sowing.
- Treat the seeds against seed born diseases before sowing.
- Follow furrow sowing
- Compact the soil around the seeds after sowing.
- Avoid thick sowing.

— Maintain uniform and proper depth of sowing
— Water the seed beds and seed pans regularly.

7.a Precedure

7.4 a. *Preparation of seed bed*

Materials required.

(i) Hand kudali or pick-axe
(ii) Spade
(iii) Soil leveller
(iv) Line rope
(v) Metallic tape
(vi) Leaf mould

7.a.5 **Procedure**

— Measure and mark the required area
— Dig the marked area to a depth of 30-40 cm and incorporate the leafmould
— Break the clods, level and bring it to a fine tilth.
— Prepare the raised beds of size 300 cm length, 100 cm width and 15 cm height.

7. b. *Preparation of seed pan*

7.b.4 **Materials required**

(i) Seed Pan (35 cm diameter and 10 cm height) or seedflat.
(ii) Wooden flat (of 60 cm long, 30 cm wide and 10 cm deep).
(iii) Row makers.
(iv) Crocks (large, medium and small size)
(v) Pot mixture (one part each of sand, loan and two parts of fine leaf mould).
(vi) Water can with rose.
(vii) Coarse sand.
(viii) Required seed mater

7.b.5 **Procedure**

— Clean one seed pan.
— Cover the drainage holew by placing a large crock with its concave side down.
— Place some medium sized pieces of crock over and by the side of the large crock.

— Put a layer of crocks broken upto the size of large pea seeds, the entire drainage material making a depth of about 3 cm.
— Sprinkle 2-3 handful of course sand on the corck pieces forming a thin layer to prevent fine soil from clogging the drainage.
— Fill the remaining space with pet mixture leaving 2 cm headspace.
— Leave the pot mixture and compact it with slight pressing.
— Water the seed pan copiously.
— When the water has drained away, the seed pan is ready for sowing.

7.c. *Sowing of seeds*

7.c.4 **Materials required**

(i) Seed material
(ii) Dibbler
(iii) Row maker.
(iv) Sand (to mix with very minute seeds)
(v) Water can with rose
(vi) Soil leveller

7.c 5 **Procedure**

— Make shallow furrows 5 cm apart in the sood bed and seed pan.
— Sow the seeds in furrows with a spacing of 1-2 cm apart to the required depth.
— Cover the seeds with fine sand or leaf mould.
— Compact the seed by hand or soil leveller.
— Water the bed or pan with rose can.

7.6 Observations

The pupil should record the following observations.

Time taken for germination
Uniformity in germination
Compare the efficiency and economy of raising.
Seeding stocks in seed bed and seed pan.
Germination percentage.
Record weak seedlings.

Record the observations in the following table for seed bed and seed pan separately.

Record the observations in the following table for seedbed and seedpan separately

Sl. No.	Kind of seed	No of seeds sown	No of seeds germinated on different days						Total No of seeds germinated	Germination percentage	Remarks
			4th	6th	8th	10th	12th	14th			

7.7 Expected behavioural outcome

The pupil acquires the following abilities to :

— prepare raised seed bed;
— prepare seed pan or seed flat and do sowing;
— understand the importance of the drainage in raising the seedlings;
— know the method of sowing the seeds
— know the importance of depth of sowing.

The teacher should evaluate the pupil for the above abilities.

7.8 Questions

(i) Mention the disadvantages of sowing the seeds in seedbed.

(ii) Seedlings of costly F_1 hybrids are raised in seed pans. Why?

(iii) Why do you prefer raised seed bed to flat bed? Give reasons.

(iv) What are the factors that influence the depth of sowing?

(v) Why the growing of seedlings in seed beds is restricted to certain horticultural crops?

Activity Unit : 8

TRANSPLANTING OF NURSERY PLANTS

8.1 Instructional objectives

The pupil should be able to .

- understand the importance of transplanting horticultural plants;
- learn different methods of transplanting;
- know the requirements of horticultural plants while transplanting,
- know the importance of plant hardening.

8.2 Relevant information

What is transplanting?

The process of transplanting consists of moving the plants from one place to another with the intention of having them transplanted in the new location for their continued growth.

What is the importance or transplanting?

The art of transplanting is widely practised in horticultural work. It is important in the growing of vegetable crops, flowers and fruits. The building sites are made attractive; parks are established; highways are provided with shade; fruit orchards are established and flowering plants are rendered more valuable for adopting this practice. Besides, many vegetable or flower plants are raised in the seed beds and later removed to the main field.

Methods of transplanting

Following are the three important methods of moving plants.

Bare-rooted transplanting

Shifting.

Balling and Burlapping

Bare-rooted transplanting

In this method, the plant is removed with its roots from the soil in which it has grown, and is replanted in a new location The root system of a plant moved in this way is seriously damaged by physical injury. Nevertheless, this method is used widely for herbaceous plants and for deciduous trees and shrubs

Shifting :

Under this method the plants are initially reared in pots or containers and later moved intact to a large container or to a permanent location. In this method the soil remains intact, with little or no damage to the root system. The plant species that do not stand transplanting well are successfully moved by this method.

Balling and Burlapping

Almost the same results obtained in the shifting method may be obtained for larger plants by balling and burlapping. In this method, the plants are dug to include the main roots intact in a ball of earth which is supported by burlap. This procedure is commonly used in moving evergreen plants and also deciduos speices durig the growing season.

What is hardening and its importance?

Hardening is a process by which the plants are conditioned to stand adverse conditions after transplanting to the field with varied conditions such as, higher or lower temperatures, wind, dry soil or air, and hot sunshine. This is done by subjecting the plants to relatively lower temperatures and gradually withholding the moisture.

Hardened plants have a better developed root-system Such a root system obviously is able to supply the top more adequately with moisture than a plant not hardened. The plants which are subjected to hardening are more adequately supplied with stored

food, which promotes development of new roots. Furthermore, hardened plants do not lose water by transpiration so rapidly as those not hardened Therefore, the hardened plants can stad transplanting shock better than the ones which are not hardened.

8.3 Precautions

- Herbaceous plants should be removed from the seed bed with least damage to their roots.
- Transplanting should be done either early in the morning or late in the evening ..
- Transplant evergreen fruit plants with a ball of earth.
- Defoliate evergren fruit plants while transplanting.
- While transplanting large plants, burlapping must be, done.
- Take care that the plant stem is buried to the same point as it was in the nursery

8.4 Procedure

8.4(a) *Bare-Mooted transplanting*

8 a.4 Materials required

i. Digging fork (for large plants)
ii Transplanting trowel (for small plants)
iii. Water can
iv Secateur
v. Metallic tape
vi. Line rope
vii. Required stock plants.

8.a.5 Procedure

- Copiously irrigate the plants to be lifted for transplanting.
- Lift the plants with the help of a digging fork and remove the dead and dried roots with the help of a secatuer
- Mark out the positions for transplanting
- Dig pits (size of the pit varies with the size of the plant).
- Fill the pit with a mixture of 3.2.1 parts of manure, red earth and sand,if the soil is not good.
- Water the pit copiously 2-3 days prior to transplanting to facilitate proper settling of soil
- On the day of transplanting, make a hole (sufficient to spread the root) in the centre of the pit.
- Spread out the roots in the hole in their natural position and

cover with soil or manure mixture.
— Press the soil round the plant to ensure the contact of roots with soil
— Water the plant copiously.

8.b *Shifting*

8.b.4 Materials required

i. Container stock plant.
ii. Digging fork
iii. Water can
iv. Metallic tape
v. Line rope

8.b.5 Procedure

— Water the selected container stock plant copiously.
— Remove the plant from the container with a ball of earth.
— Follow the procedure given under 8.a.5 for planting

8. *Balling and Burlapping*

8.c.4 Materials required

i. Digging fork.
ii. Gunny cloth
iii. Water can
iv. Metallic tape
v. Line rope
vi. Required stock plants
vii. Coir or suthli

8.c.5 Procedure

— Water the stock plant a day in advance to facilitate easy lifting.
— Lift the plant with a ball of earth and press the soil around the roots and secure the roots by burlapping.
— Wrap around the top of the plant with gunny cloth to facilitate handling and to protect the branches (burlapping).
— Follow the procedure given under 8.a.5 for planting.

8.6 Observations

The pupil should record the following observations :
Number of plants established successfully under different methods of transplanting.
Percentage of success (establishment).
Record the observations in the following table of each of the method.

Sl. No.	*Method of transplanting.*	*No. of plants transplanted.*	*No. of plants successfully established.*	*Remarks*
1.	Bare-roots			
2.	Shifting			
3.	Balling			

8.7 Expected behavioural outcome

The pupil acquires the following abilities to :

— learn the skills of lifting the plants ;
— understand different methods of transplanting ;
— decide optimum time for transplanting ,
— learn how to prepare pits for transplanting.

The teacher should evaluate the pupils for the above abilities.

8.8 Questions

i. What is hardening?

ii. Why removal of leaves in centain plants is preferred before planting?

iii. Why planting in winter is not generally taken up?

iv. What is the relationship of reserve stored food to the recovery of a transplanted plant?

v. In what specific way does hardening enables a plant to become re-established more readily following transplanting?

Activity Unit : 9

STUDY OF SPECIALIZED STRUCTRES OF PROPAGATOIN (RUNNERS, SUCKERS AND OFF SHOOTS)

9.1 Instructional Objectives

The pupil should be able to know .

— the various specialised structures ;

— the use of various specialised structures for propagation of different kinds of plants ;

— understand the morphology and regeneration of these specialized structures.

9.2 Relevant information

What are specialized structures?

Specialised structures are the modified stem, used in vegetative propagation of plants. They are :

A) Runner

A runner is a specialized stem which develops from the axil of a leaf at the crown of a plant. It grows horizontally along the ground and strikes roots at the nodes and produces new plants. Ex. Strawberry

B) Sucker

Though strictly speaking the term sucker is applied to shoots which arise from the roots, sometimes the term, 'sucker' is applied to shoots which arise from the stem also as in pine-apple and banana. Typical example of sucker is Chrysanthemum.

C) Off-shoot

An offshoot is a lateral branch produced from the stem of a monocotyledonous plant These branches may develop root on the plant itself, or they will be induced to develop roots after separation Ex. Date palm.

It may be stated that very few horticultural crops are propagated vegetatively by making use of runner, sucker and offshoots.

9 3 Precautions

— Carefully study the morphological characters of these specialized structures

— Do not cause damage to the mother plant at the time of separation of runners, suckers and off-shoots

9 4 Materials required

i Strawberry plant
ii. Banana clump
iii. Date palm (if available)
iv Knife
v. Spade

9.5 Procedure

— Observe strawberry plants Note unusually long internodes and striking of roots at the nodes in contact with the soil

— Observe a banana clump. Note the mother plant surrounded by suckers

— Uproot a banan rhizome and observe the different stages of sprouting of dormant buds which develop into suckers.

9 6 Observations

i) Draw a portion of straw berry plant showing a runner and label the different parts

ii) Draw a habit sketch of a banana clump showing suckers around the mother plant

iii) Draw a sketch of the underground rhizome of banana showing the development of suckers in various stage

9.7 Expected behavioural outcome

The pupil acquires the following abilities to .

— familiarize himself with the morphological characters of the specialized structures ;

— understand the method of production of new plants using such specialized structures ;

— know the importance of these specialised structures in vegetative abilities

9.8 Questions

i. How are new plants propagated vegetatively in strawberry?

ii. What is a sucker? How suckers are produced in banana?

Activity Unit : 10

PREPARATION AND PLANTING OF CUTTINGS

10.1 Instructional objectives

The pupil should be able to :

— know the importance of cuttings in the vegetative propagation of plants ;

— know the preparation of different types of stem cuttings ;

— know the conditions necessary for planting of the stem cuttings for rooting.

10.2 Relevant information

What is a cutting?

A cutting is a detached vegetative part of the plant, which on separation and planting is able to regenerate the missing parts and develop itself into a new plant.

Importance of cuttings in the vegetative propagation of plant :

It is an inexpensive and quick method of propagation. Large number of uniform plants can be produced using few parent plants. It does not involve specialised skills.

Types of stem cuttings

Based on the age and maturity of shoots detached for vegetative propagation, stem cuttings are classified into .

(i) Herbaceous soft wood cuttings

(ii) Semi-harwood cuttings

(iii) Harwood cuttings

Sub-Unit : 10a

Soft Wood Cutings

10 a.1 Relevant information

Softwood cuttings are the herbaceous immature shoots separated from the plants early in the growing season. They are 15 cm long. Terminal 2-3 leaves are retained and the rest are removed Retention of leaves is essential, because the cuttings do not have enough food reserves. Though they root easily, they need special conditions such as shade and humidity for rooting. When planted, they regenerate missing roots and develop into new plants.

10. a.2 Precautions

— Do not use shoots growing in the shaded interior for preparation of the cuttings
— Do not retain too many leaves at the time of planting.
— Prepare cuttings in the cool hours of the day.
— Always plant shoftwood cuttings in shade and humid conditions.

10. a.3 Materials required

i. Plants to be propagated (stock plants)
ii Secateure
iii. Watercan
iv Knife
v. Sand

10. a.4 Procedure

— Procure 5 potted healthy pilea or coleus plants Cut and remove 10 healthy succulent 10-15 cm long shoots from each plants.
— In each softwood cutting retain 2-3 leaves at the top and remove the rest.
— Prepare a sand bed-90 cm long, 50 cm wide and 30 cm high, under shade and water it.
— Plant the cuttings in the sand bed giving a spacing of 7-8 cm within the row and 15 cm between the rows. While planting, make sure that half the portion of the cutting is buried inside the sand

— Lift the cuttings one month after planting and look for rooting at the basal portion
— If sufficient number of roots are produced, lift them and plant each rooted cutting in a separate pot

Sub-Unit : 10(b)

Semi-Hardwood Cuttings

10. b 1 Relevant information

Semi hardwood cuttings are partially matured shoots, separated from the plants during the middle of the growing season They root easily Retention of some leaves in cuttings is essential. They need shade and humidity for rooting The semi-hard wood cuttings on planting will regenerate the missing parts and develop into new plants

10. b.2 Precautions

— Do not use shoots growing in the interior shaded locations for preparation of the cuttings
— Do not use fast growing shoots.
— Plant the cuttings in shade and humid conditions
— Do not retain all the leaves in the cuttings.

10.3(b) Materials required

i. Stock plants
ii. Secateur
iii Knife
iv. Sand
v Water can

10. b 4 Procedure

— Procure 5 healthy potted gernium plants. Cut and remove 10 healthy shoots of 15 cm length from each plant
— On each cutting, retain only 2-3 terminal leaves and remove the rest.
— Give a slanting basal cut just below the basal node in the cutting
— Prepare sand bed 90 cm long, 50 cm wide and 30 cm high under shade and water it.
— Plant the cuttings for rooting in the sand bed, providing a spacing of 7-8 cm within the row and 15 cm between the rows

While planting, see that the basal two nodes of the cuttings are inserted in the soil

Water the cuttings regularly.

— Lift the cuttings one month after planting and examine for rooting at the bottom of the cutting

— If sufficient number of roots are produced, lift cuttings and plant each rooted cutting in a separate pot.

Sub-Unit : 10(c)

Semi-Hardwood Cuttings

10 c 1 Relevant information

Hard wood cuttings are fully matured and lignified shoots, detached from the plants at the end of the growing season They do not require any special conditions for rooting as compared to softwood and semi-hardwood cuttings Since they have sufficient food reserves, there is no eed to retain leaves during the planting of the cuttings. They root in the open sun.

10. c.2 Precautions

— Use fully matured and lignified shoots only for preparation of the cuttings.

— Completely defoliate the shoots after separation

— Make sure that the basal cut is oblique and close to the node and the top cut is transverse and 2 cm above the node, to maintain the polarity of the cuttings.

10. c.3 Materials required

i. Stock plant
ii. Secateur
iii Knife
iv. Sand
v. Watercan

10. c.4 Procedure

— Select 5 healthy Acalypha plants. From each plant, cut and remove 10 fully matured and lignified shoots of pencil thickness.

— Remove all the leaves retaining portion of the petiole.

— Each hard wood cutting should be15cmlong and of pencil thickness with 3-4 nodes. Length may vary according to the length of internode.
— The basal cut should be slanting and close to the node and top transverse and 2 cm above the node.
— Prepare a sand bed 90 cm long, 50 cm wide and 30 cm high, under shade or open sun and then water it.
— Plant the cuttings in rows in the sand bed at 10 cm between the row as well as within the row.
— Plant the cutting at a slanted angle and ensure that 2-3 basal nodes are buried in the rooting medium.
— Water the cuttings regularly.
— Two months after planting, lift the cuttings and examine for rooting.
— If sufficient roots are produced, lift and plant each rooted cutting in separate pots.

10.5 Observations

The pupil should record the following observations in the given table.

Table · Rooting of stem cuttings

Type of cutting	*Date of planting*	*Date of rooting*	*No. of days taken for rooting*	*No. of cuttings planted*	*No. of cuttings rooted*	*Percentage of rooting.*
i) Soft wood-cutting						
ii) Semi-hardwood cutting						
iii) Hardwood cutting.						

10.6 Calculations

$$\text{Percentage of rooting in cuttings} = \frac{\text{Total No, of cuttings rooted} \times 100}{\text{Total No. of cuttings planted}}$$

10.7 Expected behavioural outcome

The pupil acquires the following abilities to :

- prepare different types of stem cuttings for vegetative propagation of plants ;
- understand the conditions necessary for rooting of the different types of stem cuttings ;
- note the differences in the time taken for rooting of different types of stem cuttings.

The teacher should evaluate the pupil for the above abilities.

10.9 Questions

i. Why are leaves retained in soft and semi-hard wood cuttings?
ii. Why leaves are not essential for rooting of the hard wood cuttings?
iii. Soft and semi-hard wood cuttings should not be planted in open sun, Why?

Activity Unit : 11.

PROPAGATION OF PLANTS BY LAYERAGE

11.1 Instructional objectives

The pupil should be able to :

- understand the importance of layering in Vegetative propagation of plants ;
- know the different types of layering ;
- understand the medhanism of development of roots on a stem while it is still attached to the parent plant ;
- know the skills to induce rooting on the stem ;
- know the conditions required for proper rooting of layers ;
- practise layering.

11.2 Relevant information

What is layerage?

Layerage is the process of development of roots on a stem while it is still attached to the parent plant. The rooted stem is then detached to become a new plant growing on its own roots. Such a rooted stem is known as layer.

How roots regenerate on the stem?

Root formation during layering is stimulated by various stem treatments, which cause an interruption in the downward translocation of organic materials (carbohydrates, auxins and other growth factors) from the leaves and shoot tips. These materials accumulate near the point of treatment, and rooting occurs at the point of interruption.

Adventage of layering

Most methods of layering are relatively simple and can be practised out of doors or in the nursery.

Layering can give a high degree of success with comparatively less skill.

In the case of plants in which layering occurs naturally (like black raspberries, goose berries and currants), it is simple and economical method of propagation.

Limitations of layering -

Layering is an expensive method of propagation since it requires considerable hard labour and does not lend itself to the large scale techniques of mechanization.

Layered plant requires individual attention.

Number of salable plants from a given number of stock plants is limited

Methods of layering :

There are four important methods of layering.

a) Simple or tongue layering
b) Compound or serpentine layering
c) Mound or stool layering and
d) Air layering or gootee

Sub-unit : 11(a)

Simple or Tongue Layering

11.a.1 Relevant Information

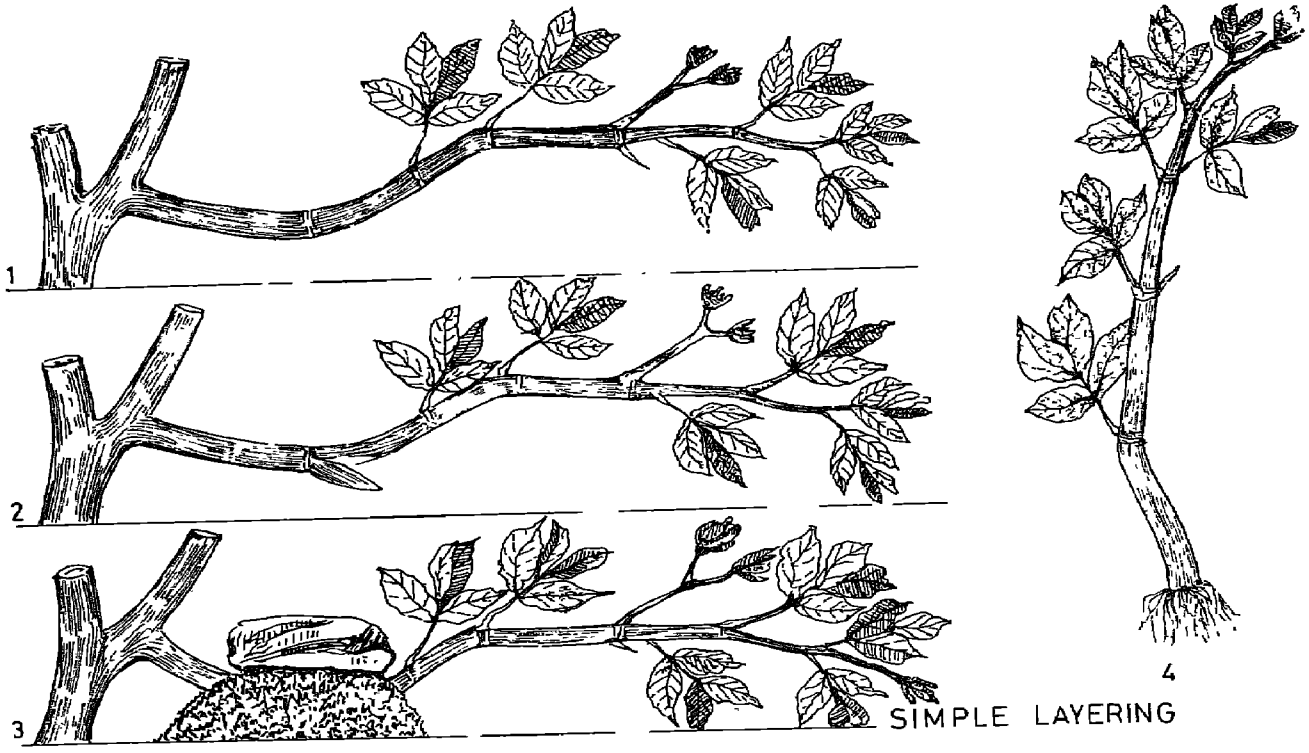
In this method, a partial cut is given on a branch and is bent to the ground and treated portion of it is covered by soil leaving the terminal end of the branch exposed. Root initiation takes place at the bent and burried portion

11.a.2 Preautions

— Eliminate light from the part required to form roots.
— Keep a stone or brick at the place covered with soil to keep the layer in place.
— Layering should be done during early spring.
— Layering branch should be nearer to the ground.
— Layered shoot should not be disturbed until the end of growing season (2-3 months).

11.a.3 Materials required

i. Knife
ii. Wood splinter (piece of wood)
iii. Stone or brick



SIMPLE LAYERING

iv. Stake (bamboo)
v. Gunny thread or twine
vi. Stock plant (Jasminium, Bougainvillage etc)
vii. Water can

11.a.4 Procedure

— Select healthy and flexible branch towards the base of the plant. It should be nearer to the ground and suficiently long (50-60 cm).
— At a distance of about 15 to 30 cm back from the tip, give a sharp slanting inward cut and insert a wood piece.
— Bend the shoot gently to the ground so that the cut part can be inserted into the soil
— Cover the rooting region with soil.
— Keep a stone on the part covered with soil to keep the layer in place.
— Drive a vertical stake into the soil by the side of the layered branch.
— Tie the branch properly to the stake with gunny thread.
— Water the layered portion regularly so as to keep it moist although, till root initiation takes place.

Sub-Unit : 11(b)

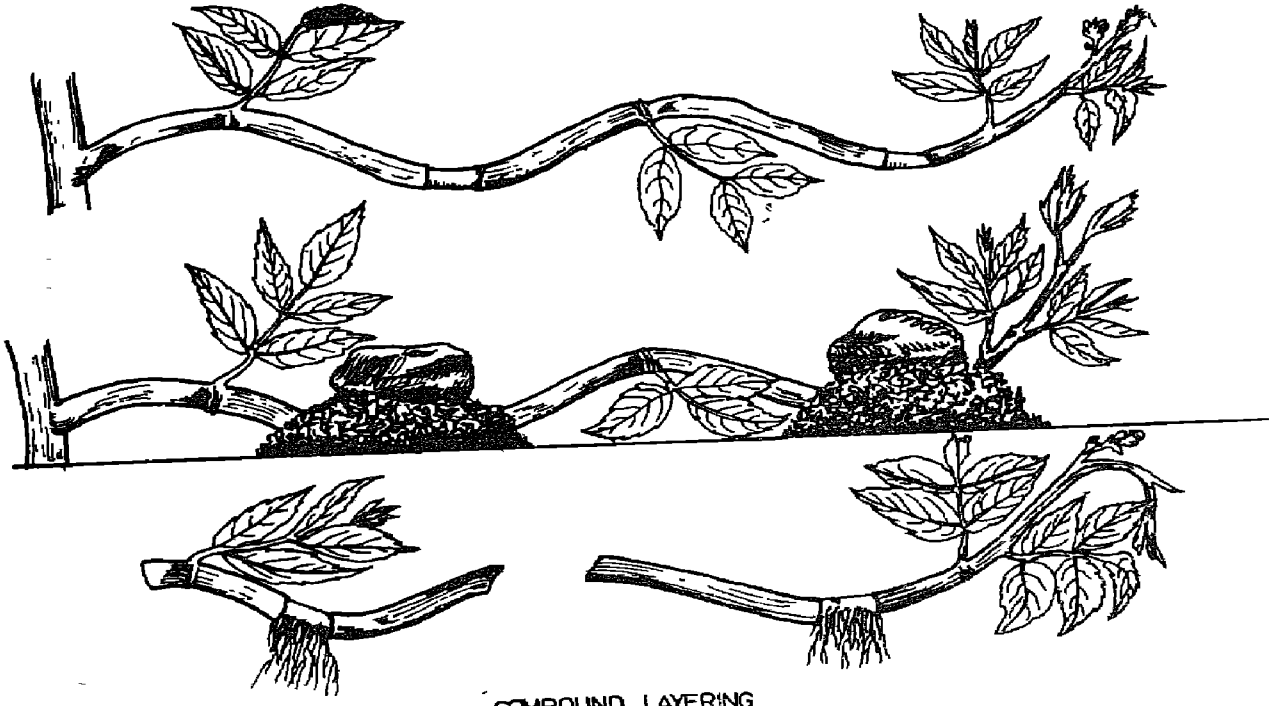
Compound or Serpentine Layering

11.b.1 Relevant information

Compound layering is essentially the same as simple layering, except that the branch is alternately covered and exposed along its length. The branch for compound layering must be a longer one, so that it can be layered at several places along the branch. This method can be followed easily for creepers like Bougainvillae, Jasminum etc.

11.b 2 Precautions

— The branch for compound layering must be a longer one
— The branch must be flexible
— The exposed part of the stem should have atleast one bud to develop a new shoot.



COMPOUND LAYERING

11.b.3 Materials required

(i) Knife
(ii) Stone or brick
(iii) Wood splinter
(iv) Stock plant (Jasminum)
(v) Water can

11.b.4 Procedure

— Select healthy, flexible and long branch (100-250 cm) which is near to the ground.
— Give sharp slanting invert cut passing through the node at 30 cm, 60 cm, 90 cm and 150 cm from the tip.
— Bend the shoot gently to the ground and insert the cut portion of the stem alternately into the soil and cover the rooting region with soil.
— Keep a stone on the covered soil to keep the branch in place.
— Water the layered portions regularly till rooted layer is separated.

Sub-Unit : 11(c)

Mound or Stool Layering

11.c.1 Relevant Information

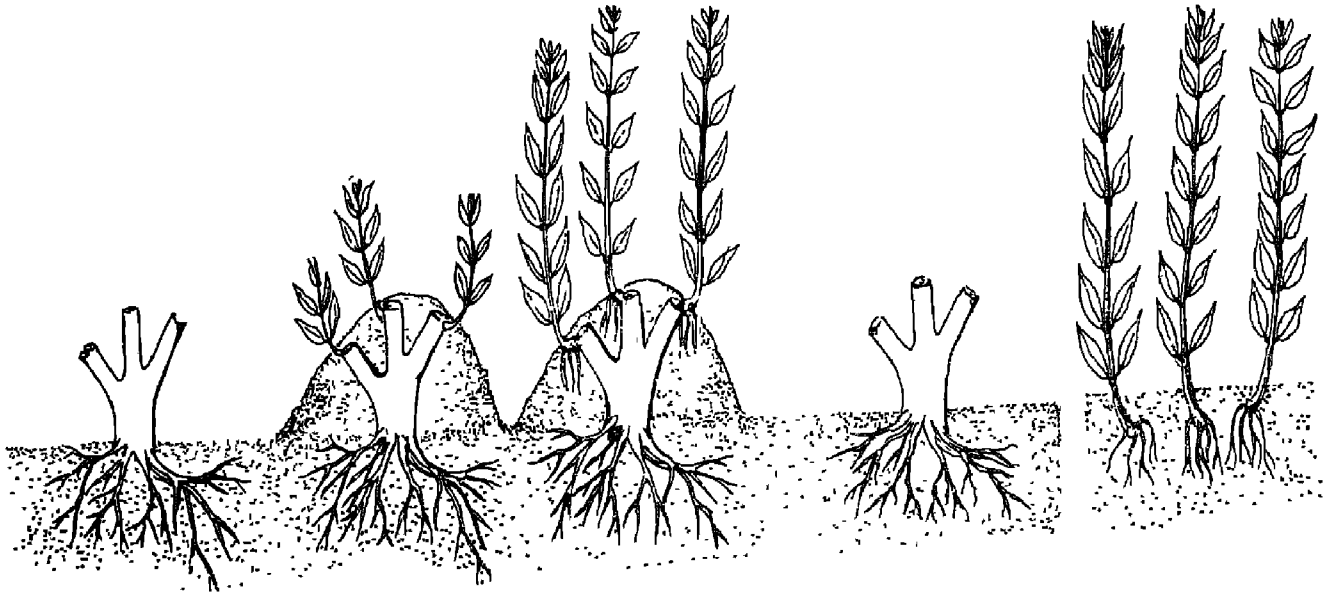
In this method, a plant is cut back to the ground level during the dormant season, and the soil is heaped around the base of the newly developing shoots After allowing sufficient time for root development, individual rooted layers are separated from the mother plant and planted. This method is practiced to perpetuate apple root stocks.

11.c.2 Precautions

— Cutting back should be done before the new growth starts the following spring.
— Mounding of soil should be done in stages.
— The height of mounding around the developing shoots should not be more than one half of its height.
— The rooted layers are cut close to their base to keep the height of the stool plant low.

11.c.3 Materials required

(i) Pruning saw
(ii) Secateur



Mound Layering

(iii) Loamy soil
(iv) Water can
(v) Stock plants of apple root-stock.

11.c.4 Procedure

— Select the plant to be mound layered.
— Cut back the plant to 2.5 cm from the ground level.
— Allow the new shoots to develop.
— When these shoots have grown 7-15 cm tall draw up the loose soil around each shoot to half of its height.
— When the shoots have grownto 20-25 cm, add soil again to half of the height of the shoot.
— Add soil again when the shoots have grown to a height of about 35 to 45 cm.
— Water the heaped soil regularly and allow sufficient time for the development of roots (2-3 months).
— Then cut the rooted shoots close to their base.

Sub-Unit : 11(d)

Air Layering or Gootee

11.d.1 Relevant information

In air layering, roots form on an aerial shoot where the stem has been girdled. The rooting medium is tied to the shoot for getting root initiation. Best rooting medium for air layering is sphagnum moss as it holds large amounts of water till root initiation and their development.

Why polyethylene film is used in air layering?

Polyethylene film, which has high permeability to gases,low transmission of water vapour, and sufficient durability to withstand long periods of weathering, has been largely used as enclosure to surround the rooting medium.

11.d.2 Precautions

— Retain large number of active leaves on the layer to speed up root initiation.
— Scrap the exposed surface to ensure complete removal of phloem and cambium to retard wound healing.
— Use moist rooting medium but it should not be too wet.

Air Layering

11.d.3 Materials required

(i) Knife
(ii) Secateur
(iii) Polythene sheet or tube (200-300 guage)
(iv) Gunny thread
(v) Sphagnum moss
(vi) Stock plant

11.d.4 Procedure

— Select the branch to be air layered.
— At a point 15-30 cm back from the tip of the shoot, make a girdle just below a node by removing a strip of bark (2 0-3 5 cm wide).
— Scrap the exposed surface gently to remove any trace of phloem or cambium.
— Cover the girdled portion with moist sphagnum moss.
— Tie the medium around the girdled portion using a polyethylene sheet or tube. Tying should be perfect so that there is no exit or entry for water.
— After observing the fully developed roots through the transparent polytehylene wraper, separate the layered shoot from the parent plant by a gradual cut.

11.3 Observations

The pupil should be able to observe and record the following .
Regeneration of roots on the layered shoot.
Number of roots developed per layer and length of root.
time taken for regeneration of roots on the layered shoot.
Record observations in the following table for each of the methods.

Method of layering :
Name of the plant :
Date of the layering :

Sl. No. of layer	*Extent of rooting*		*Date of Separation*	*Time taken for separation*
	No.	*Length*		
i.				
ii.				
iii.				

11.4 Expected behavioural outcome

The pupil acquires the following abilities to :

— select proper shoot for layering ;
— acquires needed skill for layering ;
— undertake large scale propagation of plants by layering ;
— decide appropriate time for different methods of layering ;
— know the time and method of separation of rooted layers

The teacher should evaluate the pupil for the above abilities.

11.5 Questions

i. What is layerage and how it differs from cuttage?

ii. What are the limitation of layerage?

iii. Name three important merits of layering?

iv. How does girdling a stem facilitate root formation?

v State in brief the importance of polyethylene films in air layering.

vi Name 3 each of horticultural crops which can be perpetuated by simple, compound and air layering.

i)	Simple layering	1.
		2.
		3.
ii)	Compound layering	1.
		2.
		3.
iii)	Air layering	1.
		2.

Activity Unit : 12

USE OF GROWTH REGULATORS IN PLANT

12.1 Instructional objectives

The pupil should be able to

— know the names of common growth regulators and their use in different methods of plant propagation;

— prepare solution, powder or paste of plant growth regulators;

— know the methods of applications of growth regulators in cuttings and air layers for rooting.

12.2 Relevant information

What is plant growth regulator?

It is a complex organic compound other than nutrients which when applied in minute quantities are able to promote or inhibit growth.

Kinds of plant growth regulators

The following are some of the important growth regulators used mainly for promotion of rooting in cuttings or layers.

i. Indole acetic acid (IAA)
ii. Indole butyric acid (IBA)
iii. Napthalene acetic acid (NAA)

These are auxins which promotes rooting in cuttings and layers.

Methods of application

i) Quick dip method
ii) Prolong dip method
iii) Powder method
iv) Paste method

12.3 Precautions

— The concentrations prepared should be optimum for rooting of cuttings or layers.

— Do not stock the prepared solutions or their formulations for long periods.

— Prepare the required quantities as and when required.

12.4 Materials required

i. IBA
ii. 95% alcohol
iii. Chemical balance
iv. Measuring jar (100 cc)
v. Beakers
vi. Glass rod
vii. Pestle and mortar
viii. Lanolin paste
ix. Talc or other inert powder
x. Petridish

12.5 Procedure

a. *Quick dip method*

— Weigh 1 gm of IBA on a piece of butter paper or any other non-sticky glazed paper to prepare 5000 ppm of IBA solution.
— Transfer it carefully in a volumetric flask of 200 ml.
— Pour a small quantity of 95% alcohol in the flask.
— Place the stopper over the bottle and shake slowly till the IBA is dissolved. If it does not dissolve readily, add more alcohol and shake.
— Make up the volume by adding more alcohol. Add alcohol very slowly and carefully so that you can stop when the volume reaches upto the graduated mark.
— Close the bottle and shake vigorously so that the solution is homogenous.
— Pour approximately 150 ml in a beaker of 250 ml capacity.
— Dip 10 cuttings for 5 seconds in the solution. If all the ten cuttings cannot be accommodated together, dip 5 cuttings and after taking out, dip 5 more to make 10 cuttings. There is no harm in using the same solution again and again, but care should be taken that the whole operation must be finished in a short time, otherwise the evaporation of alcohol changes the concentration.
— Hold the cuttings for a while to dry the alcohol.
— Plant in a pot or nursery bed carefully.

b. *Powder method*

— Weigh 1 gm of IBA on a glazed or butter paper.
— Transfer the material into a mortar.

— Grind throughly so that the IBA crystals become a fine powder.
— Weigh 49 gms of talc or any other inert powder and transfet the same to the mortar.
— Mix the inert material and IBA throughly in the mortar.
— Transfer the mixture into a petridish.
— Take 10 cuttings and make a fresh cut at the basal end so that the powder sticks to the cut surface.
— Dip the basal cut end of the cuttings in the growth regulator mixture, so that the powder sticks at or near the basal end.
— Tap lightly to remove excess powder.
— Plant in a pot or nursery bed.
— In case of layers also it could be applied similarly for rooting.

c. *Paste method*

— Weigh 1 gm of IBA.
— Weigh 49 gm of lanolin paste on a butter paper and transfer it to a 250 ml beaker.
— Heat the beaker so that paste starts melting.
— Add 1 gm of IBA into the melted paste and mix it by strirring it with glass rod.
— Remove it from heater and cool it.
— Take freshly prepared 10 cuttings and apply small quantity of paste to the cut end with the help of glass rod or forefinger.
— Plant the cuttings in the prepared bed for rooting.
— In case of layers also it could be applied similarly for rooting.

12.6 Observations

The pupil should record the following in the given table.

Method of Treatment	*No. of cuttings* treated	*No. of cuttings* rooted	*Time taken (days) for* rooting	*% of suc-* cess	*No. of roots/* cutting

12.7 Calculations

Pupil should calculate the following :

(i) Calculate the quantity of IBA required for the preparation of 100 ml solution of 500 ppm concentration.

(ii) Calculate the quantity of lanolin paste for preparation of 1000 ppm from 100 mg of IBA.

12.8 Expected behavioural outcome

The pupil acquires the ability to :

- understand the importance of growth regulators in plant propagation ;
- prepare growth regulator solution, powder and paste ;
- treat the cuttings or layers using different methods.

The teacher should evaluate the pupil for the above abilities.

12.9 Questions

i. Why do you use plant growth regulators in plant propagation?

ii. Name the different plant growth regulators.

iii. What is the advantage of quick dip method?

iv. Why a fresh cut is needed at the basal end in powder method of application of growth regulators?

Activity Unit : 13

RAISING OF ROOTSTOCKS FOR GRAFTING AND BUDDING (MANGO, CITRUS FRUITS BER)

13.1 Instructional objectives

The pupil should be able to

- know the importance of root stocks in grafting and budding;
- know the criteria for the selection of rootstock;
- know the various steps of raising rootstocks of mango, citrus and ber.

13.2 Relevant information

What is a rootstock?

Part of the graft which provides root system to the grafted plant

What are the desirable characters of a rootstock?

i. Plants selected for rootstock should be healthy and vigorously growing.
ii. It should be compatible with the scion.
iii. Age of the rootstock at the time of budding or grafting should be about one year.
iv. Should have adaptability to local soil and climatic conditions.

How rootstocks are raised?

Rootstocks are normally raised by seeds in the seed bed and then transplanted in the nursery bed at proper spactings for budding and grafting. They are also raised in pots and polythene bags.

13.3 Precautions

- Select fresh and healthy seeds for sowing.
- Soil media or pot mixture should be well fertile and treated with fungicides.
- Depth of seed sowing should not be very deep or shallow.

- Seeds should be treated with fungicides for seed borne or soil borne diseases.
- Seedlings should be transplanted in the nursery bed or in pots or ploythene bags at appropriate time to avoid weak growth.
- Plant protection measures should be taken in time.
- Do not allow shoots upto the height of 20-30 cm on the stem.

13.4 Materials required

i. Seeds of mango, Rangpur lime or Rough lemon and local variety of ber.
ii. Pots or seed pans, polythene bags (25x15 cm) of 250 guage.
iii. Pick axe
iv. Spade
v. Farm yard manure/compost
vi. Fine sand
vii. Water can with fine hose.

13.5 Procedure

a. *Raising of mango rootstocks*

- Prepare raised bed (1m x 5m x 20-30 cm). Upper 2.5 to 5.0 cm of the bed should be covered with sand mixed with compost or Farm Yard Manure.
- Collect the mango fruits from vigorous grwing local variety and extract the stones after removing the juice.
- Sow the seeds in the prepared beds in rows (25-30 cm apart) at a spacing 10-15 cm and at a depth of 5 cm. Sowing of seeds can also be done in 30 cm pots directly).
- Cover the seeds properly.
- Remove the seedlings along with the stone when the new leaves are bronze coloured (3-4 weeks old). Reject the seedlings with crooked roots and stems.
- Keep in shade and transplant in the prepared nursery at a distance of 50 x 50 cm.
- Weed and hoe at intervals of 15-20 days.
- Apply 10 kg nitrogen per hectare after one moth after transplanting.
- Irrigate at an interval of 7-8 days in winter and 3-4 days in summer.
- Carry out plant protection measures for insects and diseases.

b. *Raising of citrus rootstocks :*

i. (Primary nursery) :

— Prepare raised seed beds (1m x 5m x 20-30 cm) free from stones.
— Cover the upper 2.5 to 5.0 cm bed with fine sand.
— Procure seeds from the healthy and vigorous tree known for high yields.
— Wash the extracted seeds in cold water and dry in shade after treating with ash.
— Dibble the seeds in rows at 2.5 cm apart, and 1.25 cm between seeds within the row and at a depth of 0.6 to 1.25 cm.
— Spread a thin layer of sand evenly to cover the seeds.
— Irrigate with fine hose at regular intervals.
— Drench with 1% Bordeaux mixture if 'damping-off' of seedlings is suspected.
— Repeat Bordeaux mixture drenching after 15 days.

ii. (Secondary nursery) :

— Prepare raised beds.
— Lift the seedlings when they are in 4-6 leaf stage.
— Transplant at spacing of 22.5 cm between and within the rows.
— Give optimum irrigation.
— Conserve moisture by applying mulch of dry leaves.
— Do weeding and apply CAN (Calcium ammonium nitrate) and single super phosphate (2:5 ratio) and Farm Yard Manure after 3 weeks of transplanting.
— Apply little quantity of urea when the seedlings are 6 months old and irrigate.
— Remove side sprouts in order to develop straight single stem upto 25-30 cm.
— Adopt suitable plant protection measures.

c. *Raising of Ber Rootstock :*

— Collect the ripe fruits and extract the seeds.
— Remove the hard seed coat by breaking.
— Prepare the seed bed as in case of mango.
— Sow the seeds in seed bed in rows and between seeds 10 cm apart and at 2-3 cm depth. (Seeds can also be sown in polythene bags (25 x 10 cm).
— Water/irrigate regularly.
— Lift the one month old seedlings from the seed bed and

transplant in another seed bed at a distance of 20 x 10 cm between row and between seeds, to restrict root growth.

- Irrigate and weed out as and when required.
- Remove shoots from the stem upto 20-30 cm height.
- Transplant the seedlings in the prepared nursery at a distance of 45 cm between rows and 30 cm between seedlings.

13.6 Observations

The pupil should record the following observations separately for the three rootstocks in the tabular form :

Name of the rootstocks	Mango	Citrus	Ber
1. Date of Sowing			
2 Date of germination			
3. Date of transplanting			
4. Date of removal of sprouts.			
5 Cultural operations :			
i. Date of Weedling			
ii. Date of manuring			
iii Date of any other cultural operation			

Plant Protection .

Date	Pest/ Disease (Name and nature of damage)	Details of sprays/ dus-tings.	Remarks

13.7 Calculations

Percentage of germination of seeds of rootstocks. $= \frac{\text{No. of seeds germinated}}{\text{No. of seeds sown}} \times 100$

Cost of raising rootstocks :

(i)	Seed ..	=Rs.
(ii)	Labour charges for preparing seed bed.	=Rs.
(iii)	Culture operations	=Rs.
	Plant protection	=Rs.
(iv)	Manures and fertilizers, insecticides and fungicides.	=Rs.
		Total Rs.

13.8 Expected behavioural outcome

The pupil acquires the following abilities to :

— know the importance of rootstocks in grafting and budding;
— know the criteria for the selection or roostocks of mango, citrus and ber.
— know the various steps in raising of rootstokcs of mango, citrus and ber.

The teacher should evaluate the pupil for the above abilities.

13.9 Questions

i. Define a rootstock and a scion.

ii. State the advantages of using a rootstock.

iii. Describe the desirable attributes of a good rootstock.

Activity Unit : 14

PREPARATION OF GRAFTS BY INARCHING

14.1 Instructional objectives

The pupil should be able to

— raise rootstocks for grafting ;
— select suitable rootstocks for grafting ;
— select and prepare the scion shoots for grafting by inarching ;
— understand the theoretical aspects of formation of graft union ;
— understand graft incompatibility and it's causes ;
— know why grafting is done in some fruit crops ;
— know different methods of grafting ;
— prepare grafts by different methods ;

14.2 Relevant information

What is grafting?

The method of joining parts of two plants together in such a manner that they unite and function as one plant is known as grafting.

What is rootstock?

Refer to 13.2

What is scion?

The upper part of the graft combination which is taken from the desired plant to be multiplied.

Why grafting is done?

For multiplying good or desired clones and cultivars which cannot be propagated easily in large numbers by other methods of plant propagation such as seeds, cuttings, layers etc.

For imparting the beneficial effects of rootstocks and interstocks, such as dwarfing effect, as in apples; hardness in respect of

unfavourable soil and environmental conditions, as in citrus and peach; for improving the edible qualify of fruits, as in various citrus species; for controlling the soil borne diseases and nematodes, as in grapes; for controlling insects affecting the lower portion of stems, as for phylloxera in grapes.

As an aid in rejuvenation of old and seedling plants by top working (with various grafting methods).

Repairing the damage in the stem portion of the fruit trees which may be caused due to rodents or diseases by bridge grafting.

Virus indexing, as grafting makes possible to test the presence and transmission of virus in plants showing little or no symptoms.

To hasten the fruiting by reducing vegetative phase in hybrid seedlings or other seedling selections as in apple or mango.

Limitations of grafting :

Grafting is possible withing the cultivar, between two cultivars, between species within the genus and also between genera. A few experimental cases of grafting between families have also been reported in small herbaceous plants

Incompatibility :

Most of the related plants if grafted together unite satisfactorily and function as one plant are termed as compatible. Unrelated or distantly related plants grafted together, do not unite and the scion portion mostly dies. This phenomenon is known as incompatibility. Sometimes the union takes place and plants grow for a few years and then die due to poor union. This is termed as delayed incompatibility.

Symptoms of incompatibility :

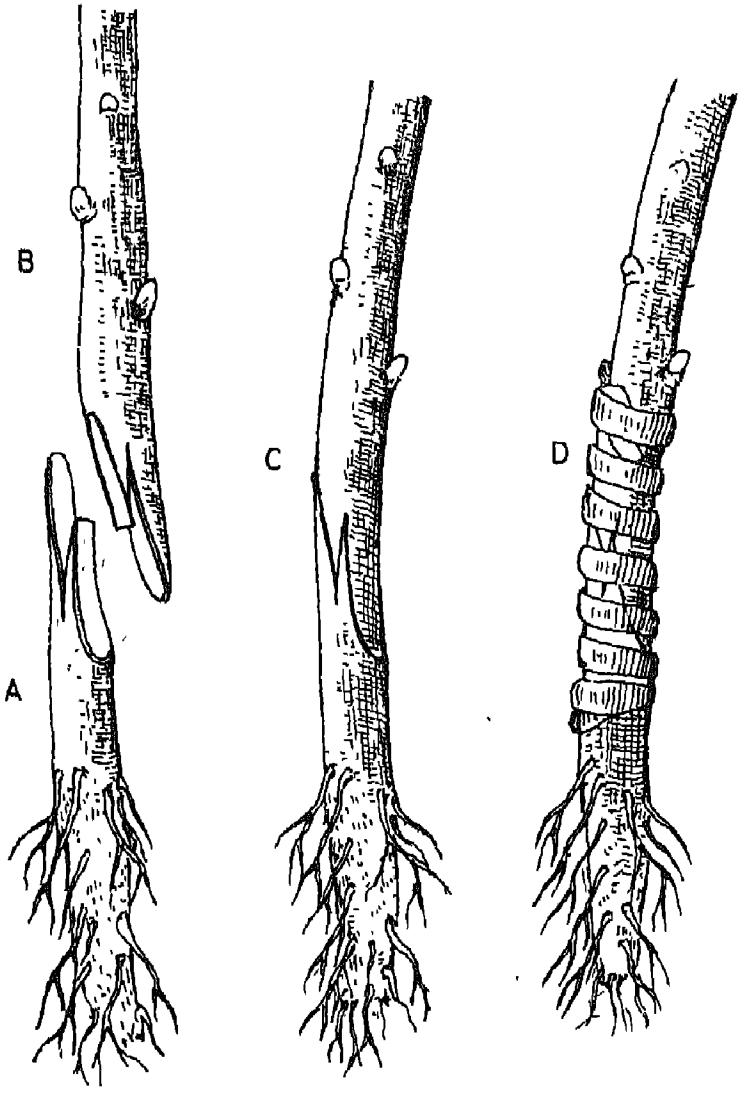
1. Grafts do not form.
2. Short life of the tree.
3. Poor health of the tree
4. Overgrowth or swelling below, above or at the graft union.

How is graft union formed?

The main idea of grafting in fruit trees is to unite and connect stock and scion in such a manner that they form and funcion as one single plant. For this, freshly cut scion is brought in contact with the freshly cut stock so that the cambium layers of both the stock and scion come in contact with each other. The outer layers of cells in scion and stock produce parenchymatous cells which form callus tissue. In this callus tissue, many cells, which are in line

A-root section B-prepared scion

C-fitted graft D-graft bound with tape



WHIP OR TONGUE GRAFTING

or inclose proximity to the cambium layers of stock and scion, differentiate into cambium cells. These new cambium cells produce new vascular tissue which connect with the vascular tissues of stock and scion. As a result of formation and joining of the new vascular tissue, the water and nutrients are transported from stock to scion and food from scion to stock.

Methods of grafting :

i. **Whip or Tongue grafting**

This is a good method for young stock plants upto 1.0 - 1.5 cm in diameter. In this, 2 to 5 cm long cut at the top of the stock and a corresponding cut at the bottom of the scion are made. It is better to make the cut in one single stroke of knife so that the outer surface is very smooth. On each of these cut surfaces, reverse cut is made, which when stock and scion are joind fits into each other, giving a large area for coming together of cambium layers of stock and scion. After joining the stock and scion, they should be tied securely with plastic tape or banana fibre.

ii. **Side grafting**

This method is very useful when the rootstock is thick (older). In this, an oblique cut of about 2-3 cm depth is made into the stock with a chisal or heavy knife. Nearly 7-8 cm. long scion stick, previously pre-conditioned is collected and a wedge like cut is made corresponding to the cut in the stock The wedge is inserted underhealth the bark of the stock and secured properly by covering with gunny piece and tying with coir string.

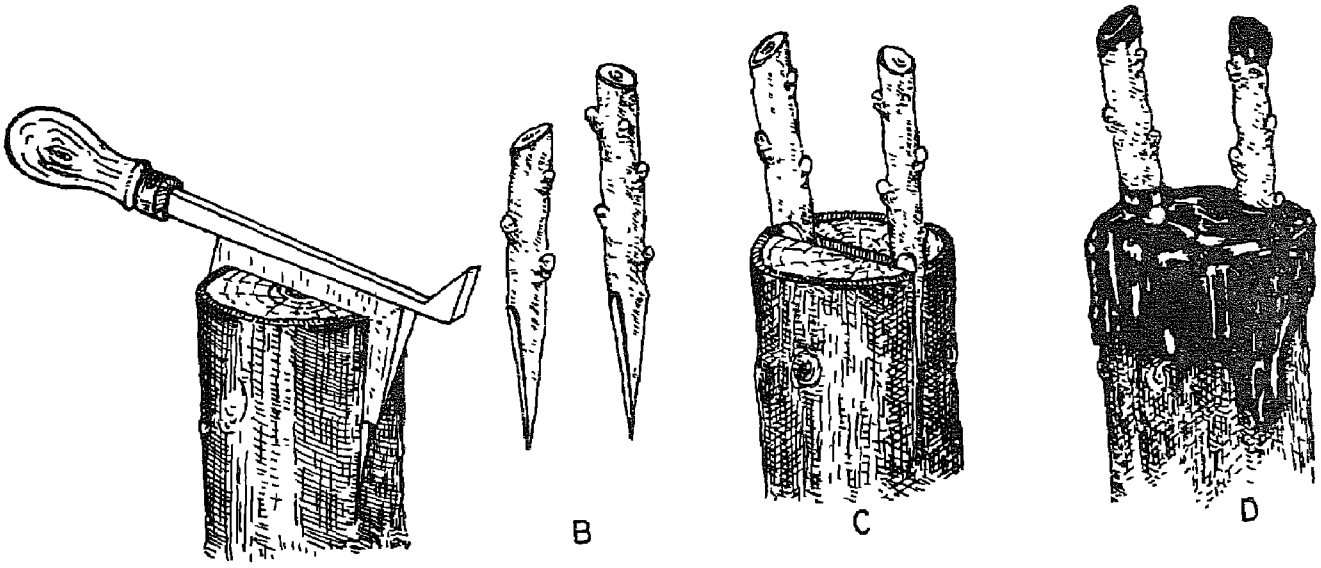
iii. Modifications of side grafting

a. *Side tongue grafting*

This method is very useful for young plants. The only difference from side grafting is that on the cut surface of stock, a further straight cut is given to form a tongue, and on the scion, a similar reverse cut is made which are fitted together and secured properly by plastic tape. This gives larger area for combium layer matching.

b. *Veneer grafting*

A shallow downward cut of 2 to 3 cm long is made on the stem of rootstock. At the base of this cut, a second cut is given to remove the bark and a little wood. The scion is cut correspondigly and secured tightly. As the thickness of stock is usually more than the scion, care should be taken to see that the cambium layers



CLEFT GRAFTING

A- Root section
B- Prepared scion
C- Fitted graft
D- Graft bound with tape

match atleast on one side of the cut surface.

c *Cleft grafting*

This method is useful for grafting older plants with thick stem. The stock is sawed at an appropriate height. A vertical split for a distance of 7 to 9 cm down the centre of the stock is made. This straight vertical split is kept open with the help of a screw driver or wedge placed in the centre of the stub. 8 to 10 cm long scions having 2 to 3 buds are selected and made into a tapering wedge. Two such wedges are inserted in the sides of the vertical split so that cambium layer of the stock matches with the scion and secured tightly with waxed cloth.

iv. **Inarching**

Inarching is also known as 'approach grafting' or scion attached method of grafting. It is done in evergreen plants which do not give good success with other methods of grafting. Ex. mango, sapota, litchi.

14.3 Precautions

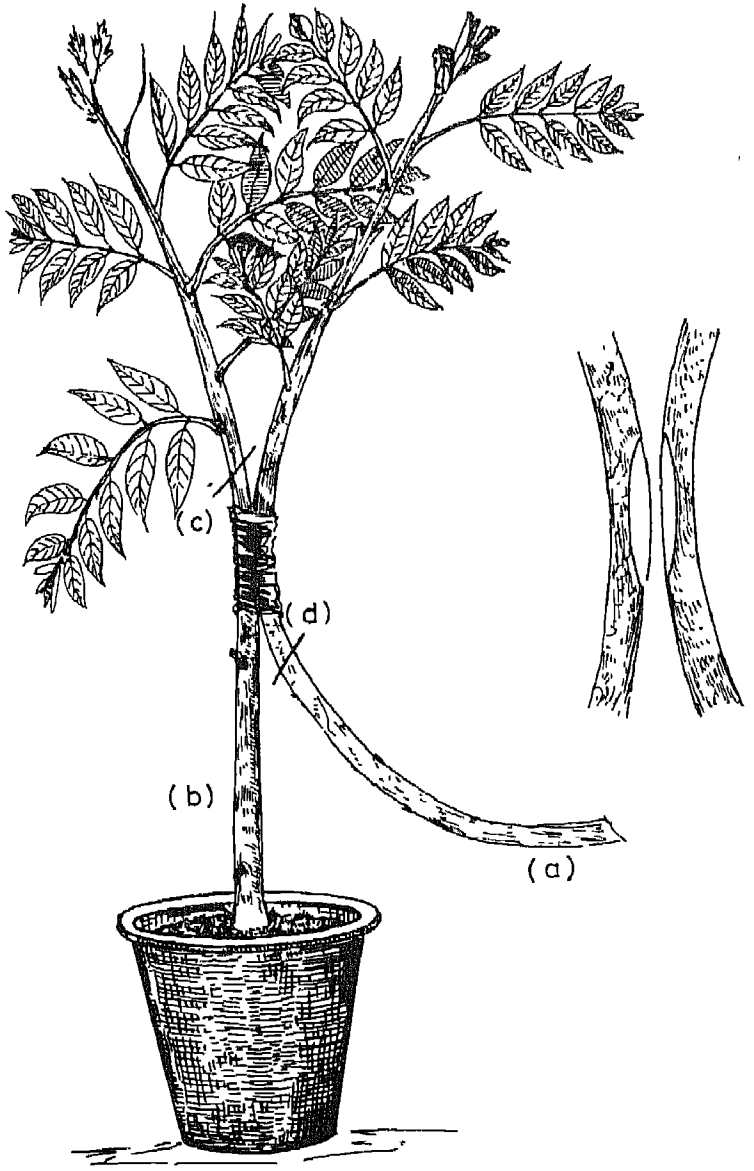
- Select healthy rootstocks.
- Select shoots and stocks of same thickness for grafting.
- Cuts on rootstock and scion should be of the same length and width.
- Tying of grafting joint should be such that it prevents entry of water in the graft joint.

14.4 Materials required

i. Grafting knife.
ii. Tying material-thick tying thread or strong plastic tape.
iii. One year old pencil thick seedling stock plants of mango raised in pots.
iv. One mother plant of mango preferably of a choice variety for collection of scion sticks.
v. Thin ropes for securing the bend branches of the mother trees in place.
vi. A few strong wooden/bamboo pegs.

14.5 Procedure

- Bend a strong branch of scion mango tree so that the thin shoots to be inarched can be brought down to the ground for inarching with the seedling mango stocks in pots.
- Secure the branch in this position by tying with pegs fixed in



INARCHING

a - Scion
b - Root-stock
c - Point of stock to cut
d - Point of scion to cut

the ground.

— Select shoots and stocks of the equal thickness.
— With the help of a sharp knife, make a 5-7 cm long cut on the rootstock at height of 15 cm above the pot.
— Make a similar cut in the selected scion shoot.
— Match both the cuts properly.
— Secure the matched shoots tightly by one hand and tie the shoots with a strong plastic tape (100-150 guage) so that they remain in the same position.
— Do this operation only when the sap in the stock and scion is active i.e., during the rainy season.
— After one month, give a 1/3 deep cut on the stock, 6 cm above the graft union.
— Give similar cut on the scion shoot below the graft union.
— Sever off the scion shoot from the mother plant and remove the top portion of the rootstock by deepening the cut further after two months from the date of inarching.
— Store the grafted plants in the tree shades for a week.
— Sprinkle water twice or thrice a day on the plants if the weather is dry.
— Four weeks after separation from the mother plants, the grafts are ready for sale or transplanting.

14.6 Observations

The pupil should record the following observations.

i. Date of inarching
ii. No. of inarch grafts made
iii. Date of separation from the mother plant.
iv. No. of inarch grafts separated which are surviving.
v. No. of inarch grafts healthy after 15 days of separation.

14.7 Calculation

The pupil should calculate the percentage success in grafting by dividing the number of healthy inarch grafts by the number of inarches made and multiply by 100.

$$\frac{\text{No. of plants surviving}}{\text{No. of grafts prepared}} \times 100 = \text{per cent success.}$$

14.8 Expected behavioural outcome

The pupil acquires the following abilities to :

— understand the need for grafting ;

— raise rootstocks ;
— select rootstocks ;
— select and prepare the scion shoots for grafting ;
— understand the mechanism of the union of stock and scion ;
— understand the graft incompatibility or compatibility and their causes ;
— know the different methods of grafting ;
— prepare the grafts by different methods.

The teacher should evaluate the pupil for the above abilities.

14.9 Questions

i. What is the role of cambium cells in graftings?

ii. What are the advantages of grafting over other methods of vegetative propagation?

iii. What is graft incompatibility?

iv. What are the symptoms of incompatibility of graft unions?

v. Differentiate between side and veneer grafting.

vi. Why inarches are separated after 2 months from the date of inarching?

vii. Why cuts are given on stock and scion before finally separating the inarch graft?

Activity Unit : 15

SELECTION AND PREPARTION OF SCION WOOD FOR GRAFTING AND BUDDING

15.1 Instructional objectives

The pupil should be able to

- understand the importance of selection of scion wood;
- understand the principle of bud forcing;
- force the buds in fruit trees ,
- identify flower and vegetative bud,
- select the scion wood for grafting and for budding

15.2 Relevant information

Storage of scion wood :

The scion wood of evergreen fruit plants cannot be stored for long even at low temperatures, whereas the scion wood of deciduous fruit trees can be stored for a few months if the scion woods are taken during dormancy. By storing at low temperatures of 0^0C (32^0 F) their storage life can be further increased. In temperate countries, scion collected during dormancy are stored in field by covering with soil for grafting in spring.

Why is selection important?

The condition of the buds in the scion wood is very important for the success of budding and grafting. If the buds start growing before the union takes place, the grafting/ budding will not be a success Also, when the bud is very much underdeveloped or in dormant condition, it takes several months for sprouting. That is why, it is important that the buds should be in such a condition of physiological maturity that they start sprouting after about 10-20 days of budding and within 20-30 days in grafting. Hence, the necessity of careful selection of scion wood.

Criteria for selection :

The following points should be taken into accounts in selecting the scion wood :

The scion wood should be of the previous season's growth but not older than one year. Current season shoots are desirable in most cases except in case of fig and olive where 2 year old scions give better results.

Flowering shoots or shoots from where the fruit has been harvested recently should be avoided, because such shoots are mostly not in an active stage of growth due to deplection of nutrients.

Select shoots with healthy, well developed vegetative buds. Vegetative buds are mostly narrow and pointed in comparison to flowering buds which are plump and broad.

The shoots selected should be vigorous. If water sprouts are available, they make a good scion material. The thickness of scion sticks is important.Generally shoots of 1/2 to 1 cm in diameter are better for graft.

As viruses are transmitted through scion material, the tree selected for collecting scion should be free from virus and other diseases.

It is desirable to select the trees with known performance of high yield and quality for taking scion material. A tree of unknown performance though clonally propagated from a choice variety should be avoided.

Preparation of scion wood :

(i) **What is the meaning of preparation of scion wood?**

Evergreen fruit trees do not undergo dormancy and as such, the buds are mostly underdeveloped during the grafting and budding season. Hence,the buds need to be activated before removing them from the mother tree. This is also known as'pre-conditioning' or 'forcing of the bud'.

(ii) **Methods of 'Pre-conditioning' or 'Forcing the Buds'.**

(a) A heavy pruning in the previous season encourages vigorous shoot growth which makes an excellent scion material.

(b) Defoliating the shoots completely or partially. intended for scion sticks, forces the development of buds. In mango, removal of 3/4 of lamina upto 15 cm shoot length, 7/10 days before separating the scion sticks from the mother tree, activates the buds adequately.

15.3 Precautions

Avoid scions with undeveloped or over developed buds

Use sharp secateur or scissors for cutting the leaf lamina to avoid damaging the buds.

15.4 Materials required

i. Secateurs and scissors

ii Mango tree of known performance

iii Cardboard/ Luggage labels (with threads for tying)

15 5 Procedure

— Select one healthy mango tree of known performance

— Select 20 straight shoots of about 18 cm length and 0 5 cm diameter.

— Remove 3/4 of leaf blade as suggested with the help of a sharp secateur or scissors in 10 shoots

— Leave the petiole along with 1/4 leaf blade intact with the shoot.

— In the remaining 10 shoots, do not remove the leaves

— Label these shoots giving the date and shoot number

— Cut the labelled shoots in about 15 cm length with the help of secateurs after 7 days of defoliation.

— Store in a closed plastic bag

15 6 Observations

The pupil should record the dates of visual observation in the following proforma and compare the results of A & B. He will observe that by pre-conditioning, the development of buds has been enhanced.

Name of fruit crop :

Date of forcing .

Date of collection of scion wood :

		(A)		(B)	
Sl No. of shoot	*Date of Obser-vation*	*Defoliated* *Total No.* of buds	*No. of swollen* bud	*Not-defoliated* *Total No* Bud.	*No. of swollen* buds
1.					
2.					
3.					
4					
5					
6					
7					
8.					
9					
10					

In a separate activity, the pupil should compare the success obtained in grafting by using forced as well as non-forced scions.

15.7 Expected behavioural outcome

The pupil acquires the abilities to ·

— understand the importance of selection of scion ,
— understand the importance of bud forcing ;
— force the buds in certain fruit trees ;
— identify flower and vegetative buds ;
— select the scion wood for grafting and for budding.

The teacher should evaluate the pupil for the above abilities.

15 8 Questions

i What is the principle of bud forcing?

ii. How do you bud force in mango and sapota trees?

iii. What is the shape of vegetative bud?

iv. Describe how you will select scion in mango?

v. What will happen if you store mango scion wood in home refrigerator at 5°C?

Activity Unit : 16

PACKING OF SCION WOOD CUTTINGS FOR TRANSPORT

16.1 Instructional objective

The pupil should be able to :

- understand the importance of proper packing of scion woods;
- understand the importance of moisture loss from cuttings during transit,
- Pack scion wood for transport

16.2 Relevant information

Advantages of transporting scion wood.

Scion wood of tropical and sub-tropical fruit crops should be utilized fresh. It is advantageous in many ways to tranship the scion wood cuttings over long distances and prepare the grafts than getting the prepared plants.

- It is very economical. The scion woods cost much less per cutting than per plant.
- Scion wood cuttings are easier to pack and handle because of their smaller volume and weight
- Scion wood cuttings can be packed in small containers which are acceptable by postal departments Plants with soil are very heavy and require very large containers though deciduous fruit plants can be transported without soil, still the volume is large.
- Evergreen plants during transit require irrigation which is completely avoided in scion wood transport.
- Easier to introduce plants from one country to other as International Quarantine laws prohibit the introduction of plants with soil Evergreen plants do not survive if the soil is removed.

Method of packing

Packing should be such that it allows minimum evaporational losses With excessive dehydration, the buds are injured - - some times to the point of death. That is why it is important that the humidity of the packed scion sticks be maintained.

For inland transport, the scion sticks are wrapped in moist, but not wet, newspaper For longer distances requiring more than a week's time in transit, they should preferably be packed in sphagnum moss. A coat of grafting wax either at both the ends or on the whole surface of sticks gives additional safeguard against water loss

Packing in plastic containers with cap are preferable to plastic bags as it reduces the mechanical injury during transit.

16.3 Precautions

- — Make the package neatly and with care
- — Write the name and address of consignee in capital letters.
- — Write 'Live plant material-Rush' to addressee' on the package in bold letters
- — Material should be accompanied by phytosanitary certificate, if sent abroad
- — For foreign consignment enclose 'Import permit' if needed by law of importing country.

16 4 Materials required

i. Scion wood cuttings of mango-20 nos
ii. Grafting wax-250 gm and spirit lamp for melting the wax.
iii. Brush for applying wax.
iv. Tube type plastic containers (5 cm dia. X 18 cm long with caps of preferably screw type) -5 nos.
v Sphagnum moss -50 gms.
vi Packing carton- One
vii Paper shreds, thread, needle, electric insulation or any adhesive tape.
viii Container (any type) for soaking moss.
ix Ordinary markin cloth 1/2 meter

16.5 Procedure

- — Select 20 healthy scion wood cuttings of mango, tie with a thread in a small bundle.
- — Apply melted grafting wax with brush at both the ends of each cutting.

— Take 50 gm dry sphagnum moss.
— Soak the moss in water for an hour.
— Squeeze the moss throughly to drain off excessive moisture.
— Wrap the cuttings with the wet moss all-around
— Enclose the cuttings with moss in the plastic container of 5 cm dia x 10 cm long. (For deciduous fruit plants size should be 5 cm x 30 cm).
— Screw the cap tightly.
— Apply adhesive tape to seal the cap joint.
— take a rectangular cardboard box of 12 x 15 x 22 cm size.
— Put the plastic tube in the cardboard carton.
— Pack tightly by pressing paper shreds around the plastic tube. Ensure that sufficient paper shreds are packed all around the tube to avoid loose shunting.
— Close the carton
— Wrap the carton with ordinary 'markin' or any rough quality white cloth
— Sew the cloth ends tighly to give it a rectangular appearance.

This way the package is ready for mailing as 'Air mail' or 'Air Freight' parcel to any other country or 'Surface mail' or 'Air mail' transhipment within the country

16.6 Expected behavioural outcome

The pupil acquires the following abilities to .

— understand the importance of proper packing of scion wood for long distance transhipment ;
— pack scion wood for transport ,
— know how moisture loss from scion wood during transit can be minimized.

The teacher should evaluate the pupil for the above abilities

16.7 Questions

i. Why do we need to transport scion wood?

ii. Suggest methods of packing of scion wood material.

iii What is the care to be taken during packing?

iv. What is the role of wax application on scion wood cuttings?

v. Why you use moist sphagnum moss and not dry moss?

vi. What will happen if the newspaper and moss have excessive moisture?

Activity Unit : 17

PROPAGATION OF MANGO BY STONE GRAFTING

17.1 Instructional objectives

The pupil should be able to :

— prepare rootstocks for grafting ;
— prepare scion material for grafting ;
— take care of grafted plant till the plants are hardened ;
— undertake the operation of stone grafting.

17.2 Relevant information

Why stone grafting in mango?

Amongst the fruit crops grown in India, perhaps, mango is the most important. The grafted mango plants are prepared commercially by adopting simple approach or inarch method of grafting. Though the percentage success in grafting of mango is satisfactory, the procedure is combursome and also time consuming. Hence, the need for a better method of preparation of budded or grafted plants.

The stone grafting method is comparatively more efficient, less time consuming for large scale multiplication of choice mango varieties and less expensive

What is stone-grafting?

It is simple method of wedge grafting where the scion shoot of desired mango variety is inserted into the tender split stem of the sprouted mango stone.

Raising of mango-stones :

Mango stones free from stone weevil infection are collected from healthy mango fruits during the season. These stones are washed in water throughly to remove the dirt and other extraneous

matter Preferably they are treated with fungicide before planting The procedure for preparation of nursery beds is given in the Activity Unit 7 The mango stones sown in the nursery beds start germinating in about four weeks of sowing Mango stones are also raised in polythene bags, the details of filling polythene bags are given in a separate previous Activity Unit.

Selection of stock

Germinated seedlings which are quite succulent with leaves bronze in colour, serve as stock plants for grafting purpose

Selection and preparation of scion

The details are furnished in Activity Unit-18 "Softwood grafting in plants" The pupil is advised to see for the details in that Unit

17.3 Precautions

— Make sure that the selected mango seedlings have sprouted well and have bronze coloured leaves
— Discard all unhealthy and weak mango Sprouts.
— Make sure that scion plants are prepared well for removal of scion shoots
— Preserve high humidity in the atmosphere.

17.4 Materials required

i. Sprouted healthy mango stones raised in nursery beds or in polythene bags having tender leaves.
ii. Scion tree of desired quality with prepared bud sticks
iii Grafting kinfe
iv. Secateur
v. Wet cloth
vi Polythene bags
vii Polythene paper strips (1 5 cm wide and 45 cm long)
viii. Pot mixture for potting grafted plants
ix Potting shed for keeping grafting plants
x Water cans.

17 5 Procedure

— Select sprouted healthy mango stones raised in the nursery beds or in polythene bags
— Remove the top with the help of a sharp knife at a height of 7-8 cm from the ground
— Give vertical cut through the stem to a length of about 4-5 cm splitting the stem into two halves
— Insert the prepared wedge-shaped scion stick in the split end of

the stock and fix firmly.

— Tie the so prepared graft by polythene strip firmly.

After care of the stone grafted plant .

— Remove the plants raised in polythene bags to the potting shed after the operation.

— Plant the naked stone grafted plants in polythene bags in the same manner as the plants were potted

— Transfer such potted grafts to potting shed and water to soak the entire pot Take care to see that water is not poured on the graft joint.

— Protect the plants from fungal diseases or pests by undertaking proper plant protection measures

— Take out the diseased and dried plants. If the scion dries up new sprouts on the stock may be developed for repeating grafting

— Take out the grafted plants once they have made sufficient growth. Direct exposoure to rain is to be avoided

17 6 Observations

The pupil should record the following observations .

i) Stock plant used

ii) scion material used

iii) Dat eof operation

Sl. No.	*Date of obser-* vation.	*No. of stone* grafts prepared	*No of stone* grafts sprouted.	*No. of days req-* uired for sprouting	*Percentage successful* grafts	*No. of plants* survived after 10 months

17.7 Expected behavioural outcome

The Pupil acquires the abilities to

— identify the appropriate time required for stone grafting ;

— decide the appropriate stage of growth of stock and scion for

stone grafting ;

— prepare sprouted mango stones for stone grafting ;
— prepare budsticks of scion plant for stone grafting ;
— take care of the budwood during transit and to prepare for stone grafting ,
— perform the operation of mango stone grafting ;
— take care of the grafted plants in potting shed till they have made sufficient growth, including the plant protection measures.

The teacher should evaluate the pupil for the above abilities.

17.8 Questions

i. Why stone grafting is done in mange? Explain with reasons

ii. How will you decide the appropriate time of stone grafting?

iii Detail the procedure to be followed in preparing scion and stock materials for mango stone grafting.

iv. What precautions will you take in the aftercare of stone grafted mango plants?

v. Describe the procedure of mango stone grafting.

Activity Unit : 18

SOFTWOOD GRAFTING OF PLANTS IN SITU

18.1 Instructional objectives

The pupil should be able to

- raise stock plants *in situ* till they are grafted ,
- prepare stock and scion plants for grafting ;
- prepare the bud sticks after their removal from the mother plant ;
- perform the operation of grafting *in situ* ;
- take care of the grafted plants till sufficient new scion growth takes place.

18.2 Relevant information

Why are plants propagated by in situ grafting?

Choice varieties of fruit crops are raised by adopting vegetative method of propagation The plants raised in the nursery are transplanted in the field when they have made sufficient growth. However, all plants do not respond well to transplanting. Such plants need different treatment. Such plants are raised in the permanent location and grafted *in situ*. These trees can be raised on canal roads, on fallow lands, on borders of the farm and also in home gardens. Among various fruit crops, success in situ grafting of mango has been reported from many parts of the country

It is a method of grafting in which recently matured shoot is used as scion and inserted into a cleft made in the shoot of a tender stock plant raised at the desired place.

Selction of site for raising orchard in situ.

The selection of site remains the same as is recommended for raising the orchards. Avoid saline, alkaline or highly calcereous or sticky clay soils

Growing stock plant

The stock plant is raised as per procedure described in Activity Unit 17. preferably sow three mango stones in a pit

Selection of stock plant

The stock plant grown successfully *in situ* should be at least one year old or more before undertaking the grafting operation. New shoots developed on this plant are selected. The shoots should be tender having bronze coloured leaves

Preparation of scion

Select tree of choice variety. It should be free from diseses and vigorous in growth Select shoots which are 10-12 cm long and 0.5 cm in thickness with dark green leaves. Usually such shoots are about three months old. The selected shoots should have terminal buds intact.

Remove all the leaves from the selected branches. The branches are retained on the tree for at least 8-10 days or more before they are separated and used as scion.

Collection of bud sticks

Grafting is done from March to September depending upon the locality and avilability of fresh shoots in the stock plants. The defoliated branches of scion are collected preferably in the afternoon and are wrapped in wet cloth immediately and put in a polythene bag. By now, it will be seen that the petioles on such branches have dropped.

18 3 Precautions

- Make sure that the stock plant selected has put on fresh healthy growth and the leaves are bronze in colour ;
- Retain the leaf petioles (about one cm.) on the branch while defoliating the branch ;
- See that the terminal bud is not damaged while preparing scion shoots.
- Check up whether the scion shoots which are to be collected have been prepared at least ten days before their removal.
- Do not remove that leaves from the rootstock plant.

18.4 Materials required

i Scion tree of desired quality.
ii. Stock plant raised *in situ* (having tender shoots with bronze coloured leaves at the time of grafting).
iii. Grafting knife
iv Secateur
v Wet cloth.
vi. Polythene bags.
vii Polythene paper strips (45 cm long and 1 5 cm wide).

18.5 Procedure

— Cut the tender shoot of the stock plant with a kinfe retaining about 8 cm of tender stem.
— Give a longitudinal cut of about 3 cm long to split the terminal end of shoot
— Select scion of about the same thickness as that of rootstock from the sticks already collected from the scion plant.
— Prepare bottom portion of the scion to a wedge shape by giving slanting cuts Take care that the bark on the remaining two sides is retained intact.
— Insert the wedge shaped scion stick into the slit of the stock shoot already prepared, and tie firmly with white polythene strip(200 guage). The wrapping should be well secured.

Care after grafting

— Retain only one successful graft *in situ*, if more are grafted.
— Remove frequently new branches sprouting from any portion of the root stock except from grafted scion branch.
— Repeat the grafting procedure if it has failed till it is done successfully
— If grafting is to be done on 4-5 year old plant, remove all side branches and retain only two shoots growing straight.
— Remove the strip of polythene when scion shoot has made sufficient growth otherwise it will penetrate into the graft joint.
— Provide all possible favourable conditions for growth of the stock plant
— If necessary, irrigate the plant.
— Protect the plant from damage due to diseases and pests.

18.6 Observations

The pupil should record the following observations ·

i. Name of root stock (*in situ*) variety.
ii. Name of scion variety.
iii Date of operation.

Date of observation.	*No. of grafts prepared.*	*No. of grafts successful.*	*Percentage of successful grafts.*	*Growth of scion in three months (cm)*	*Remarks, if any.*

18.7 Expected behavioural outcome

The pupil acquires the following abilities to :

— Select the site for raising stock plants ;
— raise the stock plants *in situ* ;
— identify the appropriate time and stage of plant growth for preparing stock and scion plants ,
— prepare the scion material on the mother tree and also to prepare the bud wood ;
— take care of the bud wood during transit and prepare for grafting ;
— actually perform the operation of soft wood grafting *in situ* ;
— take care of grafted plant *in situ* till sufficient new growth is made by the grafted plant.

The teacher should evaluate the pupil for the above abilities.

18.8 Questions

i. Explain the method followed in soft-wood grafting *in situ*. Name the fruit plants in which it is followed.

ii Explain the advantages of soft-wood grafting *in situ*

iii How will you prepare scion shoots for soft-wood grafting?

iv. What after-care is required for softwood grafted plant?

v. Which is the suitable season for softwood grafting *in situ*?

Activity Unit : 19

PROPAGATION OF PLANTS BY BUDDING

19 1 Instructional objectives

The pupil should be able to .

- understand the importance of budding in vegetative propagation of horticultural plants ,
- know the special uses of budding ,
- know the different methods of budding ;
- understand the importance of cambium in the union of bud joint ,
- know the optimum season for budding ,
- bud the stock plants.

19 2 Relevant information

What is budding?

Buding is also a method of grafting wherein only a single bud with a piece of bark is used as the scion material which develops into a plant after successful union of the stock and bud

Why budding?

- to perpetuate the clone that cannot be readily reproduced by other methods of propagation
- to obtain the benefits of certain root-stocks (for cold hardiness, disease resistance, salt tolerance etc)
- for changing the cultivars of established plants (top-working).
- for hastening the growth of seedling
- for virus indexing.
- for getting a desired shape to the trees

What are the limits of budding?

Since one of the requirements for a successful bud union is

the close matching of the callus-producing tissues (cambium layers), budding is generally confined to the dicotyledons and cone-bearing plants Both have a vascular cambium layer existing as a continuous tissue between the xylem and the phleem.

When to do budding?

Budding is done when the stock plant is in active growth and the cambial cells are actively dividing so that the bark separates readily from the wood. It is also necessary that well developed buds of the desired cultivar be available at the same time These conditions exist for most plant species at three different times, viz late July to early September, March and April and late May and early June.

Methods of budding

There are five important methods of budding viz ,

i) Sheild budding
ii) Chip budding
iii) Patch budding
iv) Flute budding
v) Ring budding

i) **Sheild budding**

This method is known as shield budding as the bud prepared has the shape of a shield It is widely used for propagating fruit trees and ornamental plants. The stock should be about 0 75-2.5 cm in diameter and the bark should be slipping very easily e g , rose etc

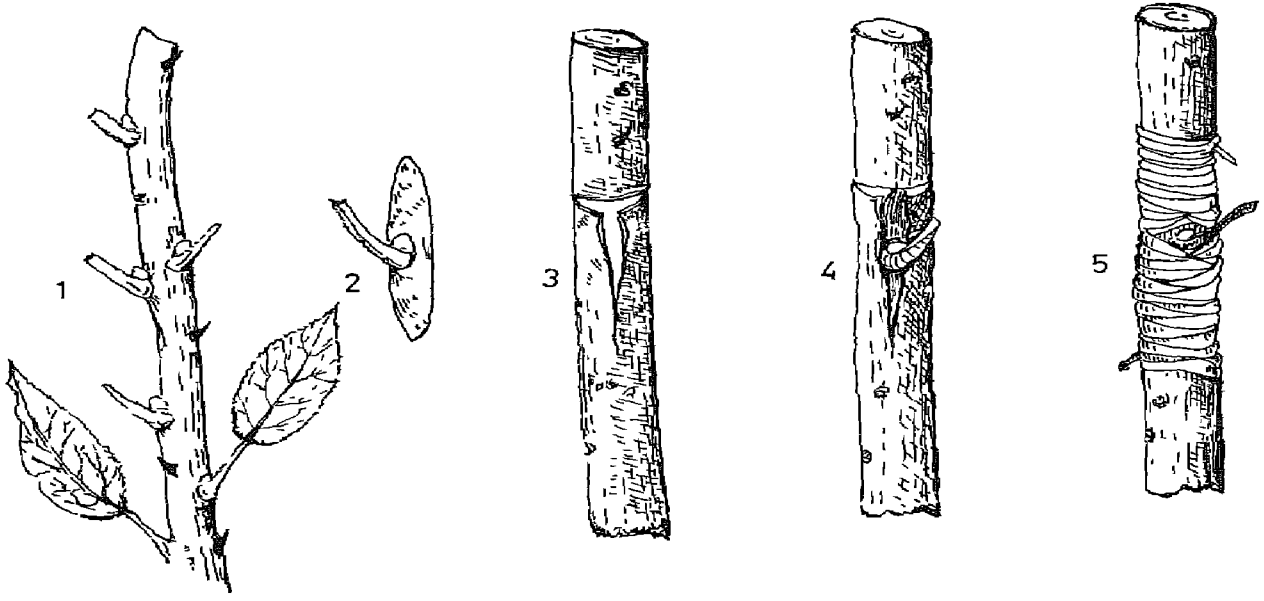
ii) **Chip budding**

This is the only method that can be done at times when the bark is not slipping This method can be used with a fairly small material (1.0-2 5 cm in diameter) A chip of bark is removed from a smooth place between nodes near the base of the stock and replaced by another chip of the same size and shape and containing a bud, removed from the bud stick, e g , grapewine

ii) **Patch budding**

In this method, a rectangular patch of bark is completely removed from the stock plant and replaced with a patch of bark of the same size containing a bud For this method, the bark of stock and the bud stick should preferably be the same (1 0 to 2.5 cm),

SHIELD BUDDING



1. Bud stick, 2 Shield bud, 3. 'T' Shaped cut on stock plant,
4. Inserted bud in 'T' slot, 5. Bud wrapped.

e g., cacao, rubber, etc.

iv) **Flute budding**

This is a modification of patch budding in which the bark removed from the stock almost completely encircles it, leaving only a narrow connection of about 1/8th of its circumference, between the upper and lower parts of the stock. The bark of both stock and bud stick should be slipping easily, e g., ber, cherry etc.

v) **Ring budding**

In this method, a complete ring of bark from the stock, and a complete ring with a bud from the bud stick are removed. In order for the two to match the size of the stock and that of the bud stick should be about the same, e g., ber, cherry etc

19 3 Precautions

Budding should be done only when the stock plant is in active growth and the cambial cells are actively dividing

Always use fresh bud sticks, If the bud sticks can not be used immediately, store them in cool and humid place

In the case of flute and ring method of budding, select the stock and budstick of the same size.

Use rubber or polythylene budding strips to wrap the bud union to hold the bud securely

The length, width, and thickness of the chip taken from the stock should be exactly the same as the chip of bud removed from the bud stick so as to get a good fit

The cuts given should be bark deep only (except in chip budding)

Remove the sprouts developing on the rootstock

Sub-Unit : 19 (a)

Shield Budding

19 a 1 *Materials required*

i. Budding knife
ii. Tying material-rubber of polyethylene strips)
iii. Plant materials (citrus root stock plants or rose root stock plants).

19.a 2 *Procedure*

— Select the required root-stock and bud stick.

— After selecting the stock plant,spot out internodal regions with smooth bark preferably at a height of about 15-25 cm from the ground level
— Give a vertical cut (cutting the bark only) to a length of about 2 5 to 3.75 cm with the help of a budding knife
— At the top of this vertical cut give another horizontal cut in such a way that the two cuts given resemble the letter 'T',
— Lift the bark piece on either side of the vertical cut for insertion of the bud.
— On bud stick give a slicing cut about 1 0 cm below the bud, and continue it upward and under the bud, to about 2 5 cm above the bud.
— Give another horizontal cut about 1 0 cm above the bud
— Now remove the shield of bark containing the bud
— Insert the bud between the flaps of bark onthe stock After insertion of the bud, wrap the bud and stock firmly in such a way that the bud is fully exposed.

Sub-Unit : 19 (b)

Chip Budding

19 b.1 *Materials required :*

i. Grafting-cum-budding knife
ii Tying material (budding tape)
iii. Grafting wax
iv Plant material (Grape vines)

19 b 2 *Procedure .*

— Select the required root-stock and bud stick.
— On a selected stock plant, 15-20 cm above the ground level, on a smooth internodal region, give a cut at an angle of 45 degrees deep into the wood.
— About 2 5 cm above the first cut, make a second cut going downward and inward, until it connects with the first cut.
— Remove the chip of bark and keep it in place again till the chip of the bud is ready for insertion
— On the selected budstick, 1.0-1.5 cm below the bud, give a cut at an angle of 45 degree and deep into the wood
— Start the second cut above the bud at a distance of 2.2 cm from the first cut,extend the cut coming downward behind the bud

and connecting with the first cut.
- Remove the chip of bark with the bud.
- Place the chip with bud in the cut given on stock and tie it in place with budding tape.
- Cover the exposed cut ends with grafting wax.

Sub-Unit : 19 (c)

Patch Budding

19 c 1 *Materials required*

i Budding knife
ii Budding tape
iii. Plant materials (mango, cacao, rubber etc)

19.C.2 *Procedure :*

- Select the required root stock and bud stick.
- On the stock plant, at the desired place, give two transverse cuts parallel to each other, and with a distance of about 2.5 to 3.75 cm between them. The cuts should be bark deep only the width of the cuts may be about 1 0 to 2.5 cm.
- Join the two transverse cuts at their ends by two vertical cuts and remove the patch of bark.
- On the bud stick, give two transverse cuts and vertical cuts of similar dimension as above and remove the bark patch with the bud.
- Insert immediately the bud patch on the stock in such a way that the horizontal cuts of the bark patch fit perfectly on the cuts in the stock plant.
- Wrap the bud joint with budding tape, exposing the bud properly

Sub-Unit : 19 (d)

Flute budding

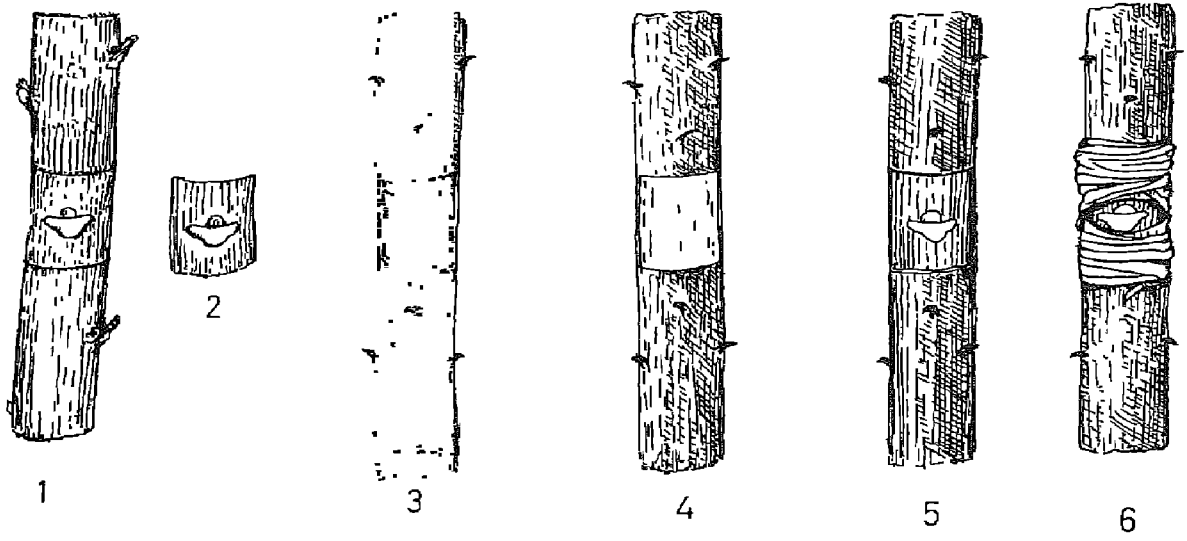
19 d 1 *Material required .*

i Budding knife
ii Budding tape
iii. Plant materials (ber, cherry, etc)

19 d 2 *Procedure .*

- Select the required root-stock and bud stick.
- On the stock plant, at the desired place, give two vertical cuts to a length of 2 5-3 75 cm parallel to each other and with a

PATCH BUDDING



1 Bud stick, 2 Patch of bark with bud removed, 3 Patch of bark to be removed, 4 Patch of bark removed, 5 Patch fitted on the stock 6 Patch bud wrapped.

distance of 1/8th of the circumference of the stock plant
- Joint the ends of these two vertical cuts by two parallel horizontal cuts and remove the bark piece
- Similar cuts are also given on the bud sticks to facilities the removal of a bark piece with bud
- Insert immediately the bud patch on the stock
- Wrap the bud joint with budding tape, exposing the bud properly

Sub-Unit : 19 (e)

Ring budding

19.e 1 *Materials required :*

i) Budding knife
ii) Budding tape
iii) Plant materials (ber, pear, cherry etc.)

19 e 2 *Procedure*

- Select the required root-stock and bud stick
- On the stock plant, at the desired place (15-30 cm above the ground), remove a ring of bark (2 5-3.5 cm) by giving two circular cuts
- Give similar cuts on the bud stick to remove ring of bark with bud
- Insert immediately the ring with bud on the stock.
- Wrap the bud with budding tape, exposing the bud properly

19 3 Observations

The pupil should observe and record the following :
Time taken for bud union.
Percentage of bud take (success)
Record observations in the following table for each of the methods .

Method of budding . . ..
Name of the clone/variety .. .
Name of the root stock .. .. . .
Date of budding ....

Sl No of budded plants	*Time taken for sprouting of the bud (days after budding)*	*No of successful budlings*	*Percentage of success*
i			
ii			
iii.			
iv			
v.			
vi			
vii			
viii			
ix			
x			

19.4 Expected behavioural outcome

The pupil acquires the following abilities to

— select the suitable plant materials for budding ,
— acquire needed skills for budding ,
— assess the proper union of stock and bud ,
— decide the optimum time of budding ,
— practise actual budding by different methods.

The teacher should evaluate the pupil for the above abilities.

19.5 Questions

i. Distinguish between grafting and budding ;
ii Mention the ideal seasons for budding in different plants (a) Citrus fruits (b) ber
iii. Mention the special uses of budding.
iv. Budding is limited to dicotyledonous and corebearing plants, why?
v. Mention the criteria for the selection of bud stick and root stock.

vi. Justify the use of grafting wax in chip budding.

Activity Unit : 20

PACKING OF PLANTS FOR TRANSPORT

20.1 Instructional objectives

The pupil should be able to

— know about the advantages or packing the plant properly ;
— know about the various packing materials ;
— know about the method of packing the plants ;
— practise packing of plants for transportation.

20.2 Relevant information

What is packing of plants for transportation?

This means that the plants which are uprooted from one place must be so packed along with the roots intact, that they reach in a sound condition the new place of permanent planting They should be able to bear various shocks during the transhipment.

Why packing is necessary?

It is necessary for the following reasons :

1. Packing protects the plant roots and shoots from drying.
2. It helps to reduce the mortality of the plants during transportation
3 It helps in absorbing the various shocks during the transport
4 Proper packing maintains the identity of the plant material after transportation

20 3 Precautions

Use labels which are not spoiled or get detached from plant in transit

Packing material should have high water holding capacity

- Packing material used should be as light as possible.
- Packing material should be so used that it absorbs the shock during the transport
- Provide sufficient protection to the union and shoot portion.
- Excessive vegetative growth should be pruned to minimise transpiration
- Avoid excessive watering to the soil ball

20 4 Materials required

i. Luggage labels of plastic or zinc labels
ii. Pencil
iii Twine
iv. Coir
v Gunny bags or polythene bags
vi Bamboo sticks
vii Wooden boxes
viii. Pruning knife or secature
ix Sphagnum moss
x India ink

20 5 Procedure

- Lift the plants carefully without injury to their roots along with a ball of earth.
- Prune the excessive vegetative growth to reduce transpiration.
- Label the plant correctly Use India ink for writing. Write clearly the name of the plant, variery and sender's name on the label.
- Cover the roots by means of a gunny cloth and securely tie with coir string.
- Deciduous plants can be packed bare rooted, wrapped in sphagnum moss
- Put the plants of one kind or variety in a separate basket or wooden box so that mixing is avoided. Do not put more than 5-6 plants in each basket/crate but you may pack upto 10 plants if they have small root balls.
- Put another label to the basket/crate giving the address of the consignee

20 6 Observations

The pupil should record the survival percentage of plants with various packing materials

20.7 Expected behavioural outcome

The pupil acquires the following abilities to :

— know about the advantages of packing the plants properly for transportation ,
— know about the various packing materials ;
— know about the methods of packing the plants ,
— pack the plant properly for transportation

The teacher should evaluate the pupil for the above abilities.

20.8 Questions

i Name the various packing material used

ii What will happen when the packing is not Proper?

iii. What will happen if the plants are not labelled before transport?

iv Why few plants are packed in a crate/basket?

Activity Unit : 21

VISIT TO NURSERY

21.1 Instructional objectives

The pupil should be able to

— acquire knowledge about suitable site and the facilities required for the nursery ,

— acquire knowledge of different components of a fruit nursery ;

— acquire knowledge about different activities carried out on the nursery area ;

— know about the demand for different plant materials and the cost of raising the plant materials in the nursery.

21.2 Relevant information

Nursery is a place where healthy and genuine disease-or insect-free plants are riased by sexual or asexual propagation methods from the promising superior plant materials for sale or for establishment of orchards

Why is nursery necessary?

i Fruit plants are the foundation on which an orchard is built If the plants are reliable and of known performance, they well be high yielding and will produce quality fruits If inferior material is planted, the mistake will be found only after 4-5 years of planting when they come into bearing. This will result in waste of time and investment made.

ii. With the icreasing technical know-how of new irrigation projects and interest in the people, the demand for fruit plants is increasing day by day Fruit growing has become a profitable enterprise

What are the different components of a nursery?

Nursery consists of the following :

i Seed-beds
ii. Nursery-beds
iii Mother plants
iv Potting yard or shed
v A packing yard and a working shed
vi A store and an office.
vii A source of water (tank/well)

What are the various activities of a nursery?

In the nursery, the following activities are carried out for raising the fruit plants

i Collection and maintenance of mother plants to serve as source of scion material for propagating different important fruit varieties
ii Propagating different types of plants by sexual and asexual methods.
iii Various interculture operations (irrigation, weeding, manuring, pruning) are done in raising the plant materials
iv. Plant protection measures are adopted for production of healthy plants
v. Lifting, packing and transportation of plant materials from the nursery as and when needed

21.3 Precautions

— Do not enter the seedbeds or nurserybeds where young plants are being raised.
— Do not remove or disturb the labels of the plants.
— Do not touch the important plant materials without the permission of the owner

21.4 Materials required

i. Note book
ii Pencil
iii Meter Scale
iv Measuring tape
v. Hand lens

21.5 Procedure

— Fix the visit before hand with the owner of the nursery.
— Enter the nursery through the main gate.

— Request the nursery owner to show the various activities in the nursery.
— Note the name, and area other eco-geographical details of the nursery
— Critically study the various components of the nursery.
— Note names of fruit plants raised, source of mother plants, source of irrigation, number and wages of labourers engaged in the nursery
— Note carefully the methods of propagation adopted for different fruit plants
— Observe the method of lifting and packing the plants
— Observe the materials used for labelling and packing of plants
— Observe the method of stocking the materials in the nursery.
— Try to know the cost of different plants/seeds.
— Try to get the information regarding investment and income from the nursery
— 'Draw' a 'plan' of the nursery in the note book showing different parts of the nursery with dimensions

21.6 Observations

The pupil should record the following observations .

i. Location and site of nursery.
ii Note the various fruit plants raised and the area developed for each in the nursery
iii. Observe the growth of plants raised by various methods of propagation.
iv. Observe and note the size and type of pots or polythene bags or containers used for propagation
v Observe the types of rooting media, pot mixture and growth regulators used for propagation of different plants
vi. Observe different operations done in the nursery and different methods of propagation in different fruit plants

Proforma for recording the data

1 Date of visit to the nursery
2. Name of the nursery .
3. Owner of the nursery .
4. Area of the nursery
5 Important fruit plants prepared and their approximate number/year :

6. Methods of propagation for different fruits :
7 Rootstocks used for different fruits :
8 Methods of raising rootstocks of :
   (a) Mango
   (b) Citrus
   (c) Sapota on other fruit trees
9. Method of stocking the plants .
10 Plants sold locally .
11. Plants sent to distant places :
12. Labourers engaged .
13 Cost of raising different plants .
14 Economics of the enterprise

21 7Expected behavioural outcome

The pupil acquires the following abilities to .

— know various components of a nursery and their size and location in the area ;
— get acquainted with the various activities in the nursery for raising different kinds of fruit plants ,
— know the demand for a type of fruit crops in the locality ;
— know the economics of nursery enterprise.

The teacher should evaluate the pupil for the above abilities.

21.8Questions

i Name various points in the selection of a site for nursery.

ii What is a nursery? Name various componants of a nursery.

iii Name four important fruit plants raised in the nursery and their method of propagation.

iv. Name and describe the kinds of pots used in nursery

v. Name the different potting media used

vi. How are mother plants planted and maintained in the nursery?

vii Write one variety and age of rootstock used for :
1 Mango 2. Sapota

viii What are the other activities associated with the raising of fruit plants?

Activity Unit : 22

REJUVENATION OF INFERIOR AND UNPRODUCTIVE OLD MANGO TREES

22 1 Instructional objectives

The pupil should be able to

— identify the inferior and unproductive old trees for rejuvenation ;

— select the superior type of trees to supply bud wood ,

— know about the various methods involved in the rejuvenation of old mango tree ,

— rejuvenate a tree by a suitable method

22 2 Relevant information

What is rejuvenation?

It is the method of converting an inferior and unproductive old tree into a superior and productive tree.

Why is rejuvenation necessary?

When a plant is :—

i. of inferior type

ii. Unproductive

iii. Old

What is the right time for taking up rejuvenation? The right

The right time for rejuvenation is rainy season or spring season for humid areas In case of top working, the branches should be cut back in the month of February for getting new sprouts. The shoots will be ready for budding or grafting in the ensuing rainy season.

22.3 Precautions

i Use sharp pruning saw to get clean and smooth cuts.

ii Avoid selecting too young or too old plants for rejuvenation.

iii. Be sure that there is an active growing condition and suitable scion wood is available at the time

22 4 **Materials required**

i Pruning saw
ii Secateur
iii Budding knife
iv grafting knife
v Polythene sheets of 250 guage
vi. Chisel
vii Hammer
viii Jute string or coir string
ix Grafting wax

22 5 **Procedure**

22 5 (a) *Top working*

— Choose the right time for this operation
— Cut then main stem of the plant to a desired height or cut the main branches in stages i e , when one branch is rejuvinated the outer is cut (After cutting, new shoots will appear. These new shoots are utilized for budding of grafting with suitable superior scion wood brought from healthy, vigorous, disease free and regular bearing trees)
— Prepare the scion wood on the mother plant a week before by defoliating the leaves
— Paste the other cut surface with grafting wax or cover by a polythene sheet and tie firmly
— Cut all branches appearing from the main tree from time to time except those budded or grafted.
— Protect the scion branches and take full care as in future they will convert the plant into a superior productive one.

22 5(b) *Crown grafting*

— Choose the right time for this operation.
— Select proper tree for rejuvenation
— Cut the main stem of the plant to a desired height or cut the main branches in stages i e., when one branch is being rejuvenated, the other is cut
— give two perpendicular parellel cuts at a distance of 2-3 cm with the help of chiesel upto 4 to 5 cm. This type of cut be made

at 3-4 places around the stem depending on the size of the trunk.

— Defoliate the scion 8-10 days before grafting, retaining the petiole portion.
— Make a slanting cut of 3 to 4 cm at the lower end of the cut
— Make another cut of 1 cm on the opposite side of the cut
— Insert the scion stick in between the bark and the flap keeping the long cut facing the inner side
— Tie the coir tight all around the bark to keep the scions in position
— Apply grafting wax all over the cut surface of the crown and over the wrapped portion
— Provide partial shade to the crown portion by providing a thatch over it

22 6 Observations

The pupil should record the following observations

Plants rejuvenated (No)	*Method of propagation followed*	*Date of cutting the plant*	*Date of operation i. e. budding or grafting*	*Date of sprouting of the scion*	*No. of plants successfully rejuvinated*	*% of plants successfully rejuvinated.*

22.7 Expected behavioural outcome

The pupil acquires the following abilities to .

— know about the various methods involved in the rejuvenating of old mango trees ,
— select inferior and unproductive old trees for rejuvenation ,
— select superior type of trees to supply bud wood ,
— rejuvenate a tree by a suitable method

The teacher should evaluate the pupil for the above abilities.

22 8 Questions

i. Why rejuvenation is necessary?
ii. What type of tree should be selected for rejuvenations?
iii. What should be the charecteristics of a tree from which scion wood is taken?
iv. Name the various methods of propagation you have used in the rejuvenation of trees
v. What care should be taken in performing various propagation method?

Appendix-I

References

1. Cheema, G.S ; Bhat, S S. and Naik, K.C , *Commercial fruits of India.* Macmillan and co Ltd ,
2. Christopher, E.P., *Introductory Horticulture,* Mc Graw-Hill book Co. Inc., N Y , 1958
3. Denisen, Ervin, L., *Principles of Horticulture* The Macmillan Co., N.Y , 1958.
4. Edmond, J.B., Senn, T.L and Andrews, F.S., *Fundamentals of Horticulture.* Mc Graw Hill book Co , New York, 1964.
5. Free, M., *Plant propagation in picture* The American garden Guild Inc. and Doubteday and Co. Inc New York, 1957.
6. Gardner, Victor R , *Basic Horticulture,* The Macmillan Company, 1951.
7. Gardner, V.R , Bradford, F C. and Hookes, H D (Jr) *The fundamentals of fruit production* Mc Graw Hill Book Co., New York.
8. Gowiley, J.H., and Homlett, F.S , *Modern Fruit Production* Macmillan Company, New York, 1961
9. Guy, W , Adriance, Fred R. Brison, *Propagation of Horticultural Plants,* Mc Graw-Hill Book Co., Inc , New York-1955.
10. Hartmann, Hudson T., and Kestes, Dale L., *Plant propagation.* Prentice Hall of India Pvt Ltd , 1976.
11. James, S , Wells , *Plant Propagation Practices* The Macmillan Company, New York, 1961.

12 Jenick, Jules, *Horticultural Science,* W.H. Freeman and Company, London, 1963.

13 Kolesnikov, V , *Fruit Biology,* Mir Publishers, Moscow, 1969

14 Mukharjee S.K., and Majumdai, P K , *Propagation of fruit Plants-SomeFacts. Indian farmer's Digest* 3(3); 33-35, March, 1970

15. Pathak, R R , D Pandey and Pandey V.S , *Propagate temperate fruit through hard-wood cuttings* Indian Horticulture. Vol. 1 22 2

16. Randhawa, G.S., *Use of Plant growth regulator and Gibberilline in Horticulture,* I.C.A.R New Delhi, 1977

17. Samiullah, R., Shivashankar, K.T., *Practical manual on Plant propagation,* Division of Horticulture, University of Agricultural Science, G.K.V.K. Campus., Bangalore, 1982.

18. Sandhu, A.S., Y.R. Ghanana and Rajwa, G.S., *Handling and transplanting evergreen fruit plants* Progressive forming X (11).7 July, 1973

19. Shoemaker, James, S , and Tesday, Bengamin, J E., *Practical Horticulture,* John Wiley and sons , Inc.. Newyork, 1955

20. Singh, Ranjeet., *Fruits* . National Book Trust of India, 1969

21. Singh, Shyam., Krishnamurthi, S., and Katyal, S L., Fruit culture in India I C A.R., New Delhi-1963.

22. Wright, R.C.M., N.D., *Plant Propagation* Ward, Lock and Cc. Limited, London and Melbourne, 1957

Appendix-II

List of Contributors

1 Dr. U.V. SULLADMATH
Professor of Horticulture and Head
Department of Horticulture, GKVK
University of Agricultural Sciences
Bangalore-560 065.

2. Dr. A.T. JOSHI
Associate Dean (Instruction)
Punjabrao Krishi Vidyapeeth,
P.O. Krishinagar, Akola,
(Maharashtra State)-444 104

3. Dr. G.C. SINHA
Scientist
National Bureau of Plant Genetic Resources
IARI Campus, New Delhi-110 012

4 Mr. R. SAMIULLAH
Asstt. Professor of Horticulture
University of Agril. Sciences, GKVK
Bangalore-560 065

5. Mr M.A. NARAYANA REDDY
Asstt. Professor of Horticulture
University of Agril. Sciences, GKVK
Bangalore-560 065

6. Mr K.T. SHIVA SHANKAR
Asstt Professor of Horticulture
University of Agril Sciences, GKVK
Bangalore-560 065

7. Dr. A.K. SACHETI
Deptt. of Vocationalization of Education
NCERT, New Delhi-110 016

8. Dr A K DHOTE
Deptt. of Vocationalization of Education
NCERT, New Delhi-110 016